INTERPRETATION OF METAL FAB DRAWINGS

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Interpretation of Metal Fab Drawings (Moran)

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Licensing

*A detailed breakdown of this resource's licensing can be found in **Back Matter/Detailed Licensing**.*

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Interpretation of Metal Fab Drawings (Moran)

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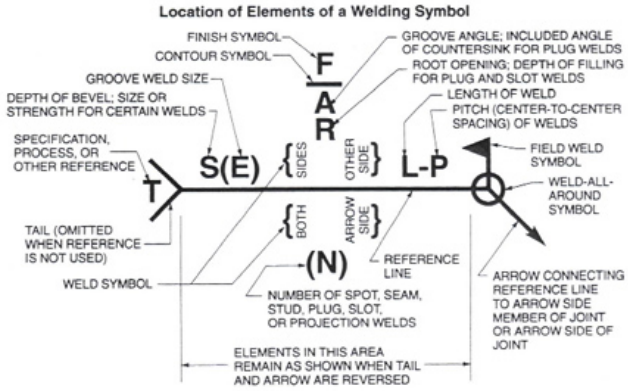
1.1: Interpreting metal fab drawings

Interpreting metal fab drawings is a course that introduces the principles of interpretation and application of industrial fabrication drawings. Basic principles and techniques of metal fabrication are introduced by planning and construction of fixtures used in fabrication from drawings. Basic tools and equipment for layout fitting of welded fabrications are utilized. Covers the use and application of the AWS welding symbols. This course will utilize blueprints and welding symbols and will apply them in classroom and in shop as practical assignments.

The largest reason for understanding this information is to communicate between all parties involved. This could include the welder, engineer, quality control, as well as many more. This is a universal language that provides clear instructions for a quality part.

American Welding Society has created a detailed publication (Standard Symbols for Welding, Brazing, and Nondestructive Examination AWS A2.4) that gives an extended amount of knowledge in this language.

Below is an overview of what the elements of a welding symbol may or may not include. The welding symbol provides a visualization for the welder or those involved to be able to apply the applicable weld to the work piece.



http://www.weldersuniverse.com/welding_symbols.html

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1.2: Blue Print Review

Blue Print Reading Review

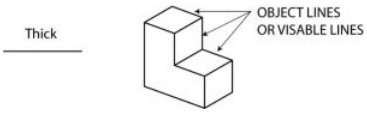
Understanding blue prints is a vital skill in the metals industry. Whether it be as a structural welder, pipe fitter, or quality control, this is the language that is universal for all individuals involved in a project.

This chapter is here to recap some line types as well as visualizing blue prints and plans.

Line Types

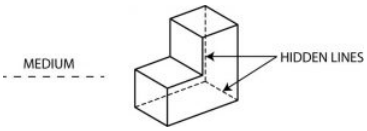
1. Object Line

A visible line is a thick line, without breaks, that indicates all edges and visible surfaces of an object. An object line may also be called a visible line.



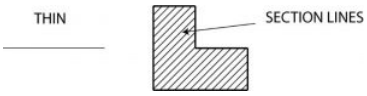
2. Hidden Line

A hidden line is a medium weight line, made of short dashes, to show edges, surfaces and corners which cannot be seen. Sometimes they are used to make a drawing easier to understand. Often they are omitted.



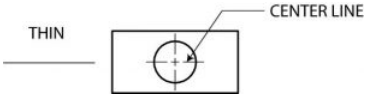
3. Section Line

Section lines are used on a drawing to show how an object would look if it were sectioned, or cut apart, to give a better picture of shape or internal construction. Section lines are very thin (size), and are usually drawn at an angle of 45 degrees. They show the cut surface of an object in a sectional view. Sections and section lines will be explained in BPR 7.



4. Center Line

Center lines are used to indicate the centers of holes, arcs, and symmetrical objects. They are very thin (size), long-short-long kinds of lines. (More detail needed?)

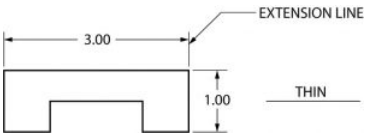


5. Dimension Line

Dimension lines are thin lines with a break for entering a measurement of some sort. The ends of the lines will also have an arrow head pointing to an extension line (below.)

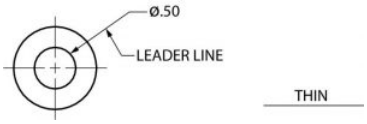
6. Extension Line

Extension lines are also thin lines, showing the limits of dimensions. Dimension line arrowheads touch extension lines.



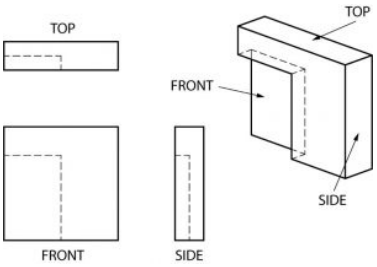
7. Leader Line

Leaders are more thin lines used to point to an area of a drawing requiring a note for explanation.

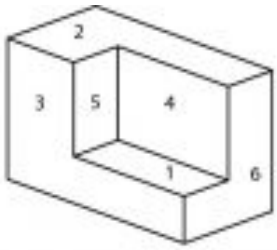


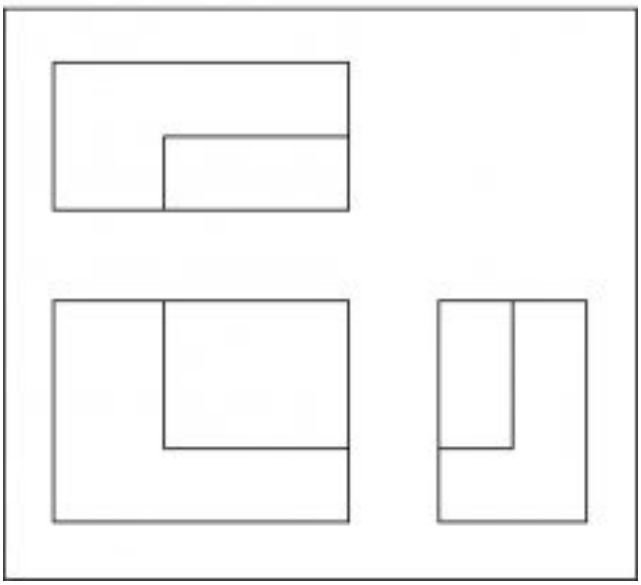
Visualizing parts

As a welder it is imperative that you can visualize the part you are building from the print. This is not always an easy task. Prints may have a variety of parts or are not detailed as well as they should be but being able to distinguish sides and faces can help decipher these harder prints.



Surface identification quiz





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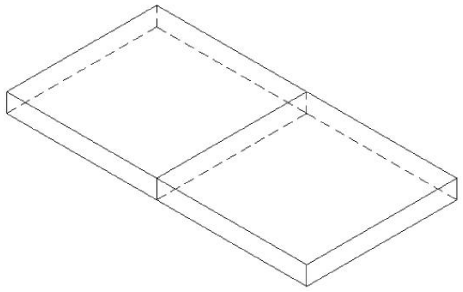
1.3: Joint types and Terminology

Terminology of joints may play a large role in communication with supervisors and others working on the same weldment. Understanding the concepts associated with joint design as well as identification of parts is critical for any metal worker.

Joint Types

There are 5 basic joint types used in the metal fabrication field:

Butt Joint: A joint type in which the butting ends of one or more work pieces are aligned in approximately the same plane. A butt joint has a possibility of many prepared faces. We will talk about these in subsequent chapters. Represented is a square groove butt joint.



Possible Welds for a Butt Joint:

Square Groove

Bevel Groove

V Groove

J Groove

U Groove

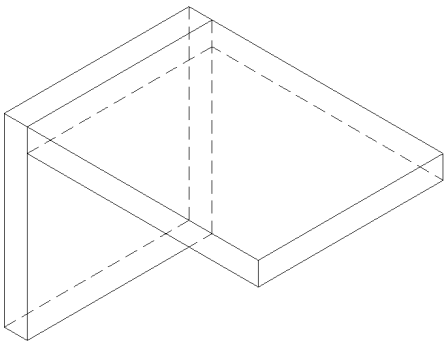
Flare Bevel Groove

Flare Vee Groove

Flanged Edge

Scarf (Brazed Joint)

Corner Joint: being one of the most popular welds in the sheet metal industry the corner joint is used on the outer edge of the piece. This weld is a type of joint that comes together at right angles between two metal parts to form an L. These are common in the construction of boxes, box frames and similar fabrications. There are variations of a corner joint, shown is a closed corner joint.



Possible welds for a corner joint:

Fillet

Edge Flange

Corner Flange

Bevel Groove

V Groove Flare Bevel

Flare V Groove

J Groove

U Groove

Square Groove

Seam

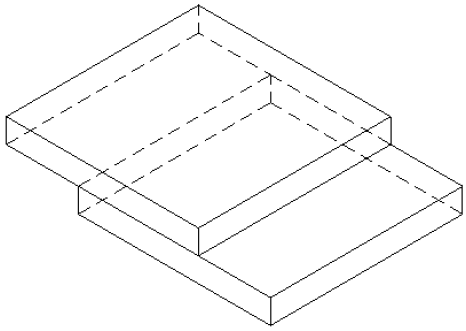
Spot

Projection

Slot

Plug

Lap Joint: A joint between two overlapping members in parallel planes.



Possible welds for lap joint:

Fillet

Bevel Groove

Square Groove

Flare V groove

J Groove

Plug

Slot

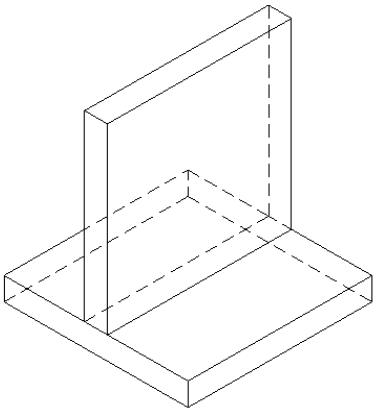
Spot

Projection

Seam

*Braze

Tee Joint: A joint which are two pieces of metal are perpendicular to each other. This is one of the most common joint that will be encountered in the metal fabrication industry.



Possible welds for a Tee joint:

Fillet

Bevel Groove

Square Groove

Flare V groove

J Groove

Plug

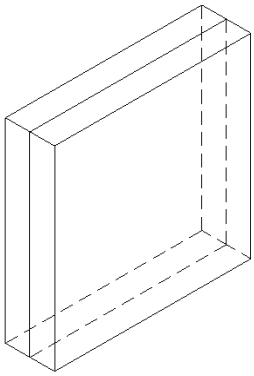
Slot

Spot

Projection

Seam

Edge Joint: A joint formed by uniting two edges or two surfaces (as by welding) especially making a corner.



Possible welds for edge joints:

Square Groove

Bevel Groove

V Groove

Edge

J Groove

U Groove

Flare Bevel Groove

Flare V Groove

Corner Flange

Edge Flange

Seam

Joints may be left as cut but some may have a prepared surface that is determined by the engineer, designer or welder. This is commonly seen with a Butt weld when the members to be joined are larger in thickness. This will be visited in subsequent chapters.

Joint terminology

Outside of specific joint types there are some terms that will play a role in deciding the correct procedure for welding or prepping the member(s) of a weldment.

Joint Root- This is the area which is in closest proximity to another member making the joint. This could be viewed as a line, area, or a point depending on the view in front of you.

Groove Face- The surface within the groove the weld may be applied to. This can be measured at an angle from the surface of the part to the root edge.

Root Edge- This is a root face that has no width (land) to it. In GTAW it is commonly referred to as a knife edge preparation.

Root Face- This part of the prepped member is the portion of the groove face that is also within the joint root. This is commonly called a flat or land in the industry. This is usually a predetermined size even though the size is not always called out. If you take the overall thickness of the member and subtract the groove depth you will be left with the root face depth.

Bevel Angle- an angle between the bevel of a member and a perpendicular plane in relation to the surface. This may be only equal to half of a groove angle if the opposite joining member is also prepped. If only a single member is prepped this is also considered the groove angle.

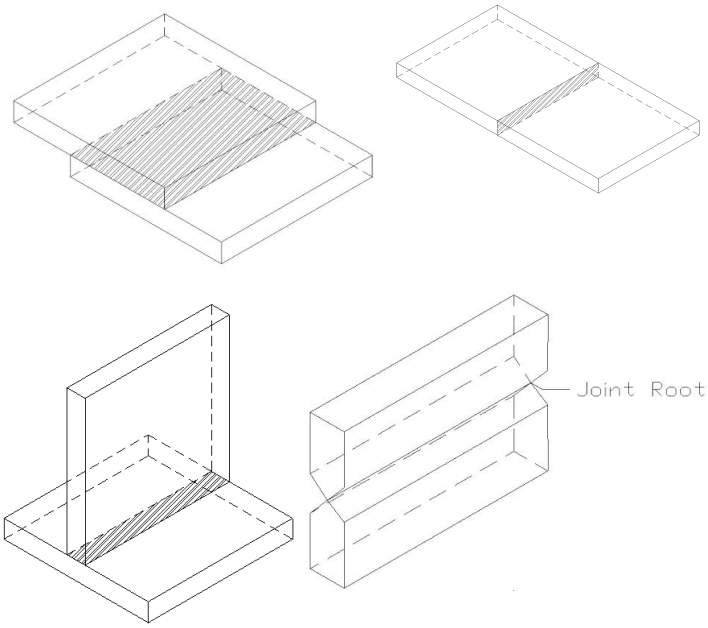
Depth of Bevel- the distance from the surface of the base metal to the root edge or beginning of the root face.

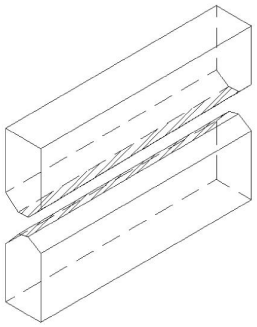
Groove Angle- an included angle of the groove between work pieces. If both members are prepared this angle is from groove face to groove face. This dimension is shown in degrees above or below the welding symbol depending on if it is arrow side or other side designation.

Groove Radius-This pertains specifically to J or U groove welds as these have a radius most commonly specific by machining.

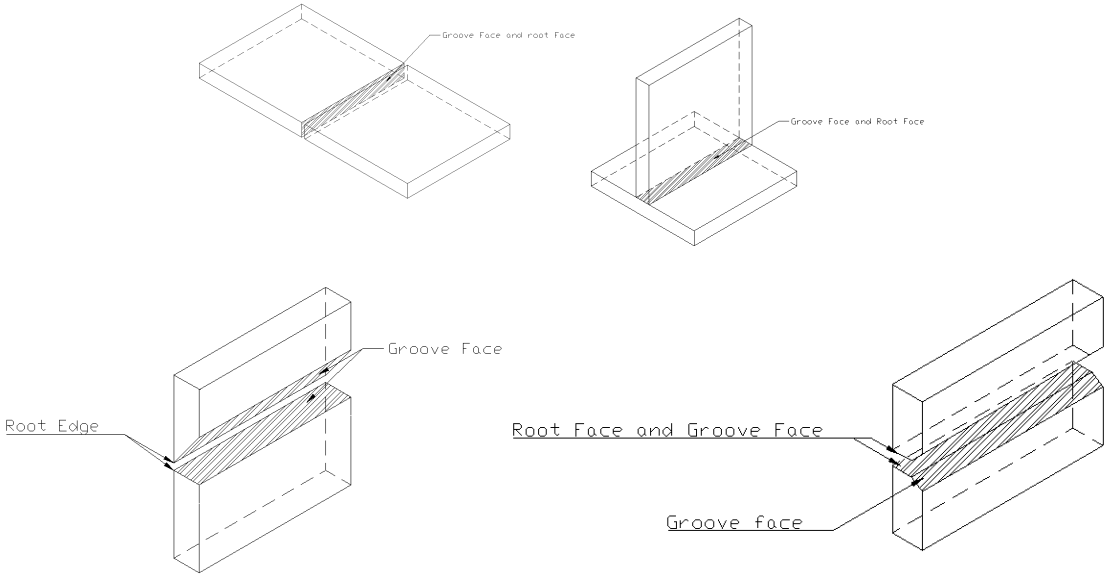
Root Opening- a gap between two joining members.

Joint Root Examples. Some may be shown with hatching.

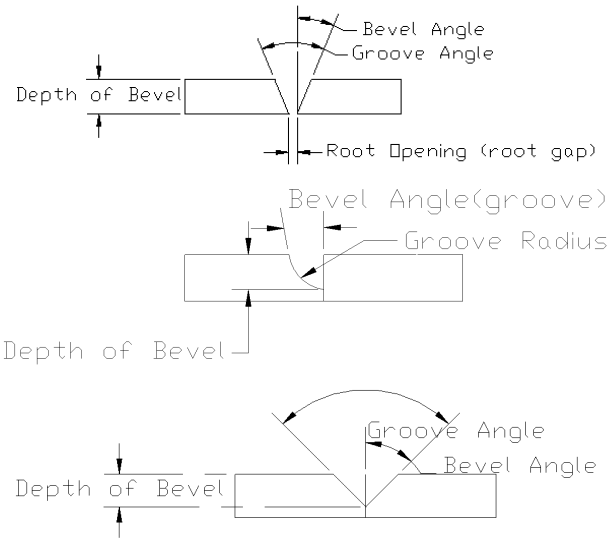


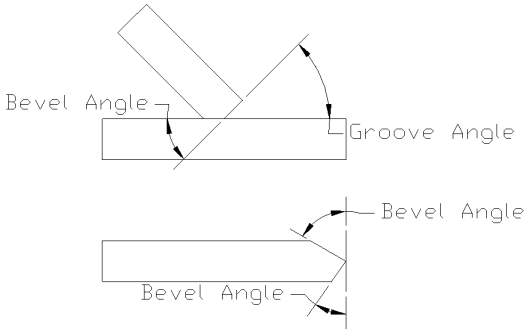


Groove Face, Root Edge, Root Face examples. Some are shown with or without hatching to better depict a visual.



Shown below are examples of bevel angle, groove angle, depth of bevel, groove radius, and root opening.





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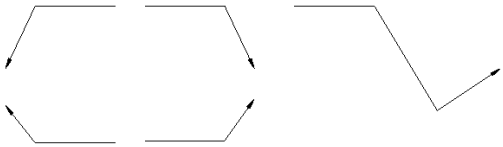
1.4: Basics of Welding Symbols

Understanding Weld vs. Welding symbol

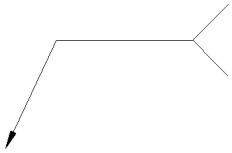
A weld symbol is not the same as a welding symbol. The weld symbol specifies the type of weld to be applied to a part. The welding symbol is made of several parts including the reference line, arrow, and weld symbol when required. The symbols in this book are a representation of what weld and welding symbols look like. There are specific design requirements when used in accordance to a blueprint.

Reference Line and Arrow

There are two parts that make up the main body of a welding symbol. These include the reference line and the arrow. The horizontal line that makes up the main body is called the reference line. This is the anchor to which all the other welding symbols are tied. The information that is pertinent for making the weld are place on the reference line in specific places. The arrow connects the reference line to the joint in which the weld(s) is (are) to be made. There are several combinations of the reference line and arrow, but the reference line will always be placed in a horizontal position. This symbol is also always read from the left to the right. If you have been around blueprints the arrow may look a lot like a leader line. They are not the same thing so be mindful when reviewing welding symbols.

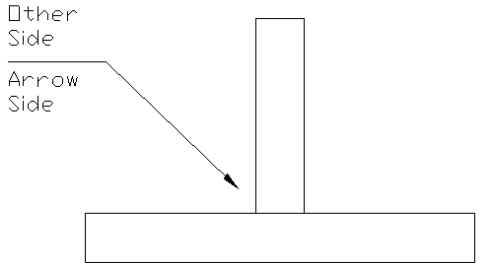


The reference line may include what is called the tail. This looks like the letter V turned sideways. Such as this >. This tail gives an area to write specifics about what weld process, welding procedure, and even material specifications are required for that specific welding symbol.

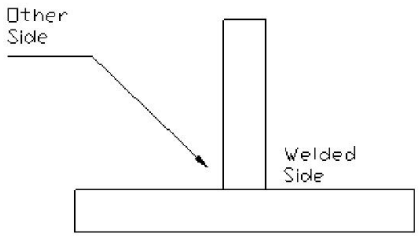


Arrow vs Other Side

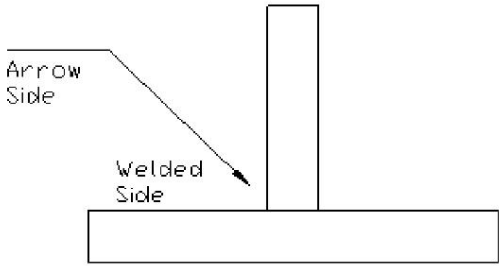
Placement of the weld will depend on placement of the symbol above or below the reference line. If the symbol has been placed above the reference line this is calling for the other side. If it is placed below the reference line this is calling for the arrow side. Other and arrow side define exactly what it is calling for. If the arrow is pointing to the right side of the joint the weld will be placed on the right side if an arrow side weld is called out. If the arrow is pointing at the right side of the joint and another side weld is called then the weld will be applied to the left side of the part.



If a weld is to be placed on the other side of a joint a symbol will be placed above the reference line.



If a weld is to be placed on the arrow side of a joint the symbol will be placed below the reference line.

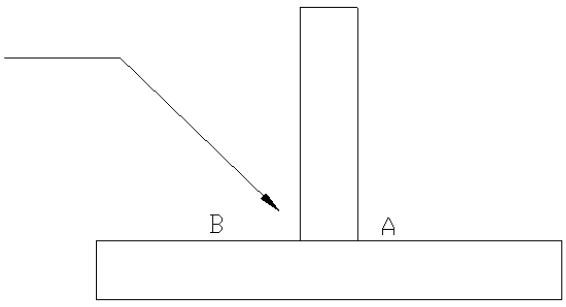


It is very important to understand the difference of these two sides as it could finish a product or if done incorrectly send it back to be reworked in order to get the correct outcome. The concept behind this may seem very simple at the moment but as we work through this book and start adding more elements to the welding symbol it may become more taxing on the thought process. The most important thing to do is break it down piece by piece and truly understand what the symbol is asking/ requiring for the weld.

At times there may be multiple reference lines. If this is the case it is important to remember the order of which the welding is to occur. The reference line nearest the arrow will be the first operation, followed by the second, and so on until all operations are complete.

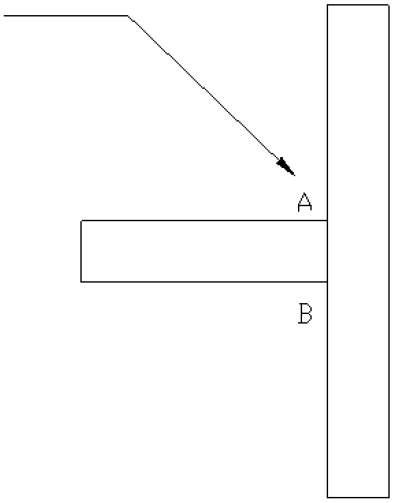
Symbol Fundamental Quiz

Label the image below with the appropriate letter (arrow/other) designation.



Letter _____ designates the Arrow side of the joint.

Letter _____ designates the Other side of the joint.



Letter _____ designates the Arrow side of the joint.

Letter _____ designates the Other side of the joint.

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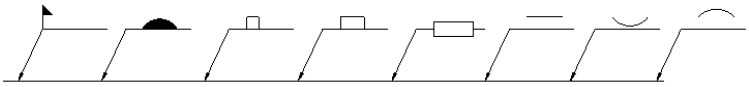
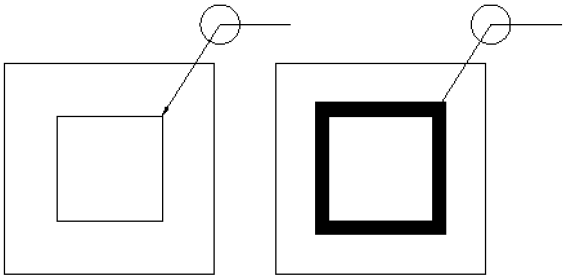
1.5: Supplementary Welding Symbols

These are symbols that are added onto a weld symbol to give further instruction or knowledge of the final product.



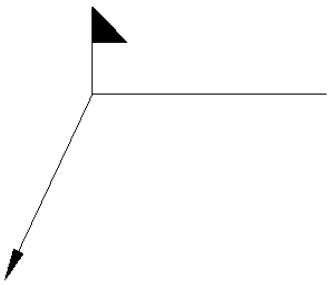
Weld all around

This symbol is simply a circle at the junction of the arrow and the reference line. This indicates that on a part that a weld could be completed around an entire joint. A common place you could see this is the junction of a square or round tube and a plate.



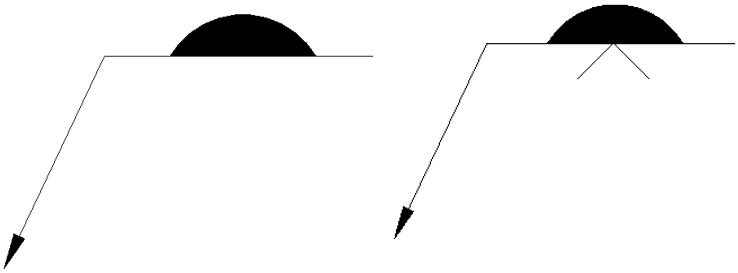
Field Weld

The symbol is a flag that will be at the junction of the arrow and reference line. This indicates that the part while may be assembled in a shop setting, its final welding procedures will be completed in the field during installation. The flag itself should point in the direction of the tail (end of reference line.) It can also be placed above or below the reference line for an other or arrow side specification.



Melt Through

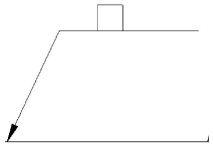
Melt through is most commonly associated with a groove weld. This is indicating you are achieving 100% penetration with a root reinforcement. This symbol can also be seen when sheet metal is being welded and there is an implied melt through in seams and joints.



Melt through may include a finishing contour as well as finishing method as parts are often cleaned up before they are sent to be painted, powder coated, or put into service.

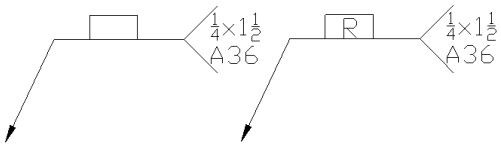
Consumable Insert

A consumable insert symbol is used when an insert is used within a welded joint that becomes part of the weld. These are commonly specified in shape, size, and material. The symbol is placed on the opposite side of the groove weld symbol. The consumable insert class must be placed in the tail of the welding symbol. This class is defined by the American Welding Society.



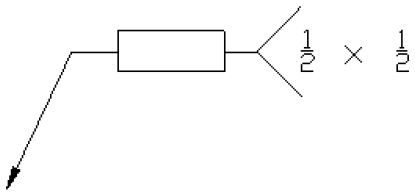
Backing

A backing strip is specified by placing a rectangle on the opposite side of the reference line from the groove weld symbol. If the backing must be removed after the welding operation has been finished, the letter R must be placed inside of the backing symbol. Material to be used as well as the dimensions must be placed in the tail of the symbol or somewhere on the drawing.



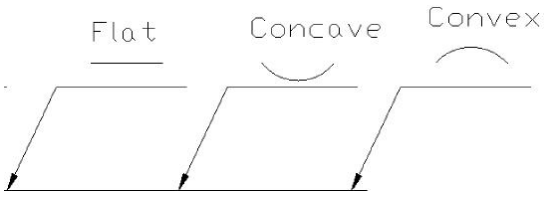
Spacer

A spacer may be used on a double groove weld. In this case both the top and bottom are prepped and a spacer is added to the middle of the groove. The symbol is a rectangle the breaks the reference line. A note on the print or in the tail can specify material and dimensions.



Weld contour

There are 3 symbols used for specifying the contour finish of a weld. This is the final appearance of a weld as it goes into service. These are commonly associated with fillet welds but sometimes will present themselves with groove welds. If a “flat” symbol is used with a groove weld it will then be called a flush contour rather than flat.



Contour symbols may also include yet another element which will show to the right of the fillet weld symbol above the contour. These are letter designations which will be for finishing methods.

C- Chipping

G- Grinding

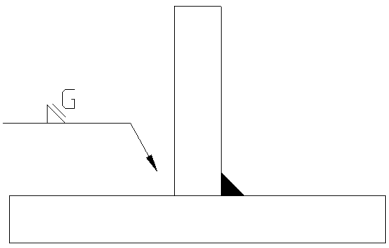
H- Hammering

M- Machining

P- Planishing

R- Rolling

U- Unspecified



Shown is a fillet weld to be applied to the other side with a flat contour by grinding.

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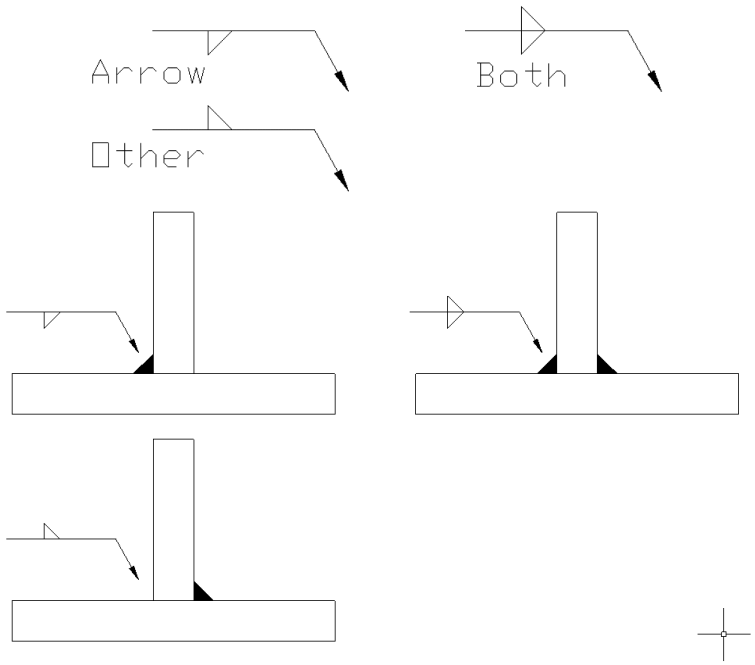
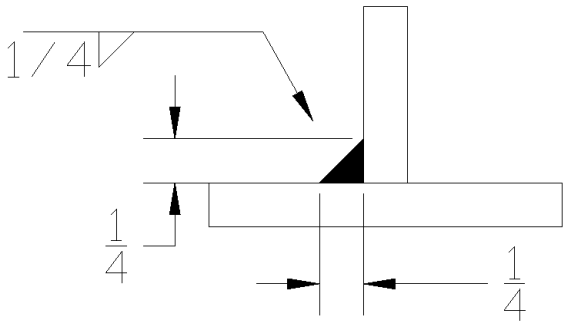
1.6: Fillet Weld Symbols

Fillet welds are one of the most common weld types in the industry. This weld is used when the joint has two members coming together to form an intersection of commonly 90 degrees. These welds can be applied on varying angles but this would be the most prominent.

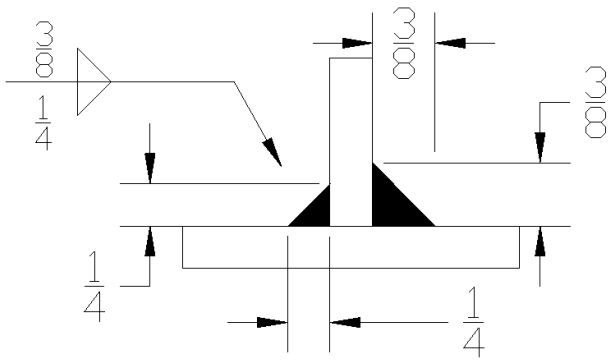
A fillet weld symbol can be used with an arrow side (below reference line) other side (above reference line) significance or on both sides (both sides of the reference line.) When a fillet weld is required on both sides of the reference line it is called a double fillet weld. The vertical leg of the symbol will always be placed to the left regardless of which way the arrow is pointing.



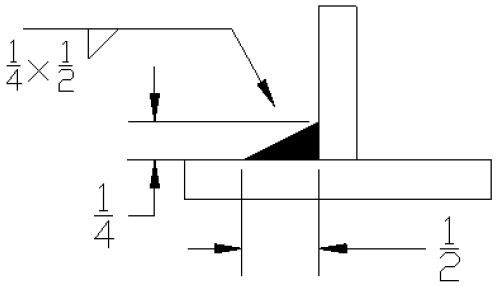
Fillet welds may have a size associated with them. This size is called out on the left side of the symbol before the vertical side. The size is indicating the leg length of the weld. If a single size is called out this is specifying that weld should have equal leg sizes. If it is an equal leg fillet weld it is not common to dimension it on the print as shown below for demonstration purpose.



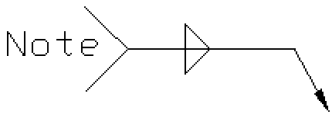
If a double fillet weld is called out the size will be shown for both sides of the joint, depending on the part these welds could vary in size so it is necessary to provide this information.



There are times when an unequal leg fillet weld is called out. In this situation the part must be dimensioned in order to apply the correct leg size to the right member being welded. This may include only one of the two leg lengths. If there were no indication of which leg is which the part could be welded incorrectly.

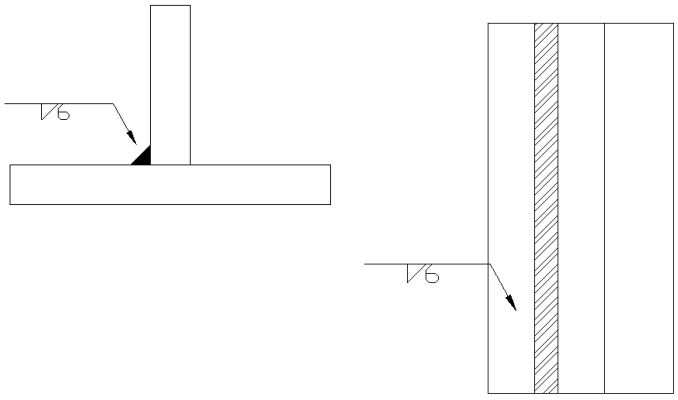


Sometimes fillet welds will not be shown with a size but will rather have a note in the tail of the symbol that gives required information for size. This is common when fillet welds will all be the same size.



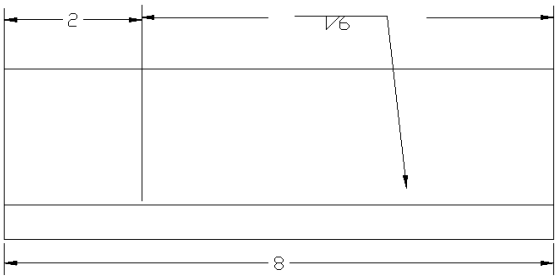
Note: all fillet welds to be 1/2" in size.

In the case of the length of a weld, this may or may not have a dimension associated with it. If the weld does not have a dimension the weld will be the continuous length of the joint. Whether the part is 2” or 60” long if it has no dimension the weld will run the length of the joint. A weld may be applied only to a specific length of a joint. This must be shown in the weld symbol to communicate the information between individuals. The weld length will be provided on the right side of the fillet weld symbol.

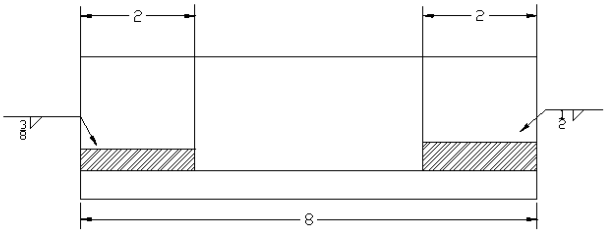


This shows a 6” fillet weld to be applied to the arrow side.

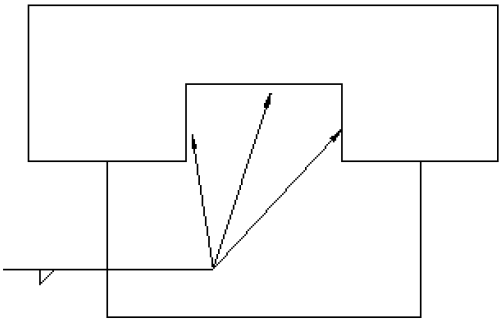
There may be times where a length is given on a part and the location of the weld will be given with a dimension in order to achieve the correct location.



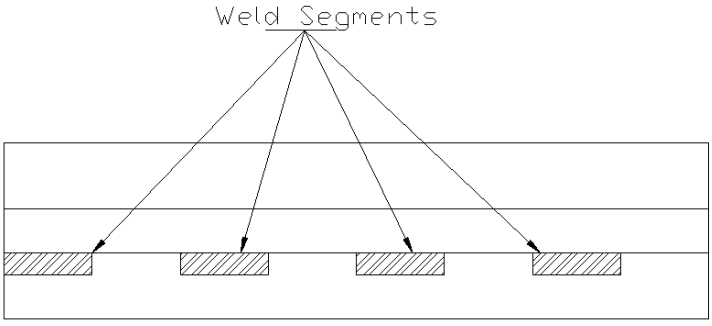
Hatching lines may be used to indicate the length of a weld instead of using a dimension on the weld symbol itself.



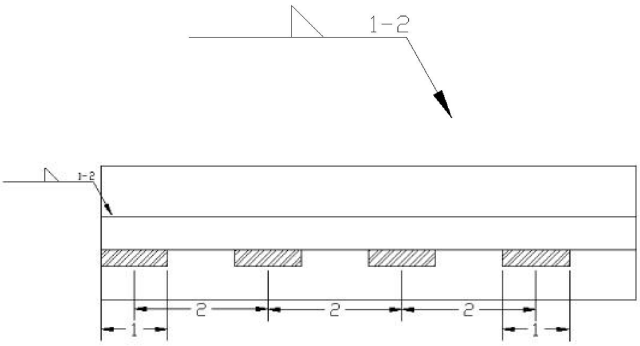
There are instances when a weld may change direction because of part geometry. If this happens it will be called out using multiple arrows off of one reference line.



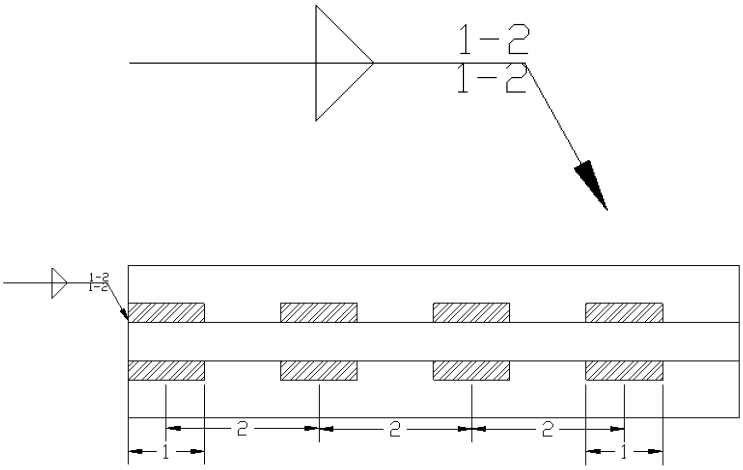
When a weld is not required to be continuous it is common to apply an intermittent weld. This means that there are gaps between the termination of one weld and the start of the next. These are called weld segments. They are commonly referred to as skip welds in the industry.



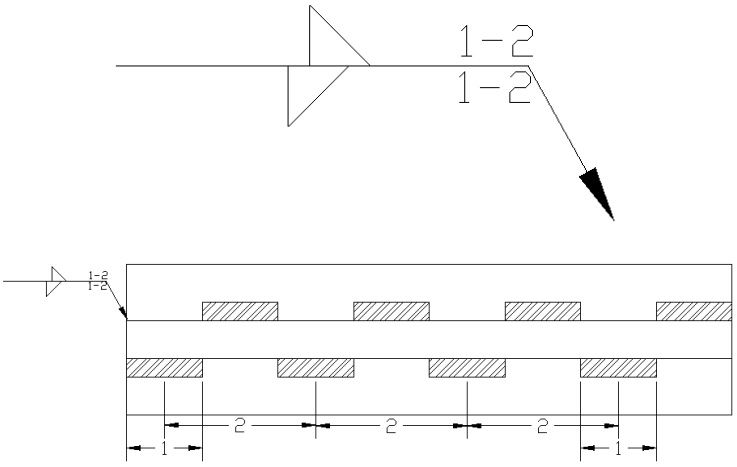
When using an intermittent weld there is a call out specified for the length of the weld and also the pitch that is to be applied. When this is shown on the right side of the symbol and it is called as the length of segment a hyphen and then the pitch of the welds. The pitch of the weld is measured as center to center of the next segment. (Ex. 1-2)



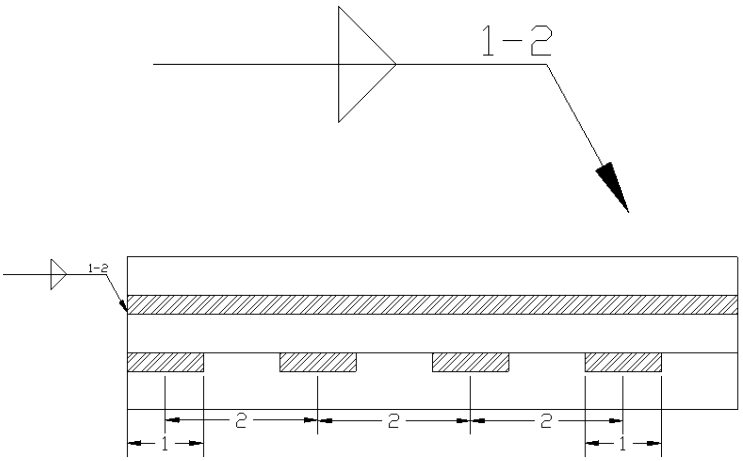
At times that there are welds on both sides of the joint and they are intermittent, this now becomes chain intermittent welding. This can be seen on long sections of a tee joint that isn't under a large amount of stress.



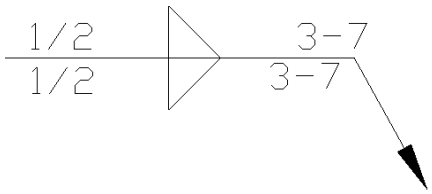
When an intermittent fillet is not a chain weld it will then be called out as a staggered intermittent fillet weld. The welds will be placed on both sides of the joint but it will be offset with one another. This offset shows on the reference line as well. It could be staggered in either direction on the reference line. Dimensions of these welds must be specified on both sides of the reference line.



If the weld is only to be intermittent on one side and a continuous weld on the other the symbol must be dimensioned individually.

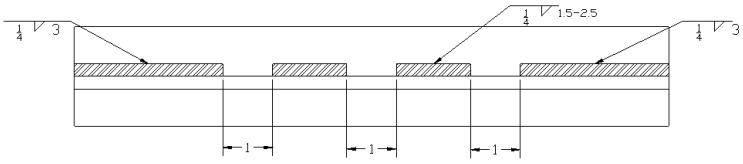


Not all pitch will be the same, or necessarily common space. You must be able to calculate the spacing between weld stops and weld starts in order to apply the correct welds to the specification. An easy way to find this distance is simply subtract the pitch from the weld length (segment.)

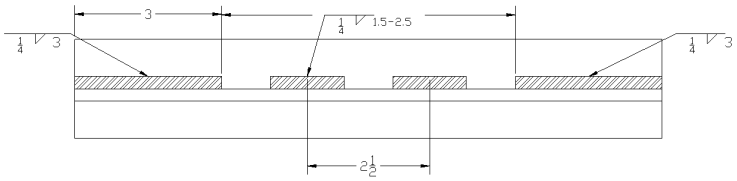


7 inches (pitch) – 3 inches (length of segment) = 4 inches (spacing in between welds)

At times there will be a mixture of continuous welding as well as intermittent welding. If this occurs the spacing between these segments will all be the same.

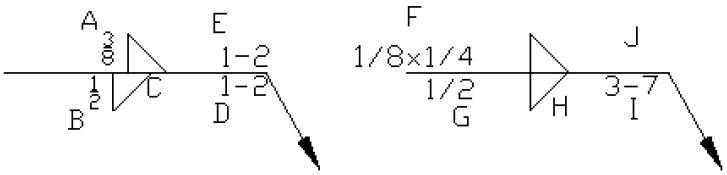


If this combination occurs welding symbols should specify continuous and intermittent on the same side of the joint. These are also often dimensioned.



Fillet Weld Quiz

Write down the corresponding information with each letter and specify what it is.



A _____ F _____

B _____ G _____

C _____ H _____

D _____ I _____

E _____ J _____

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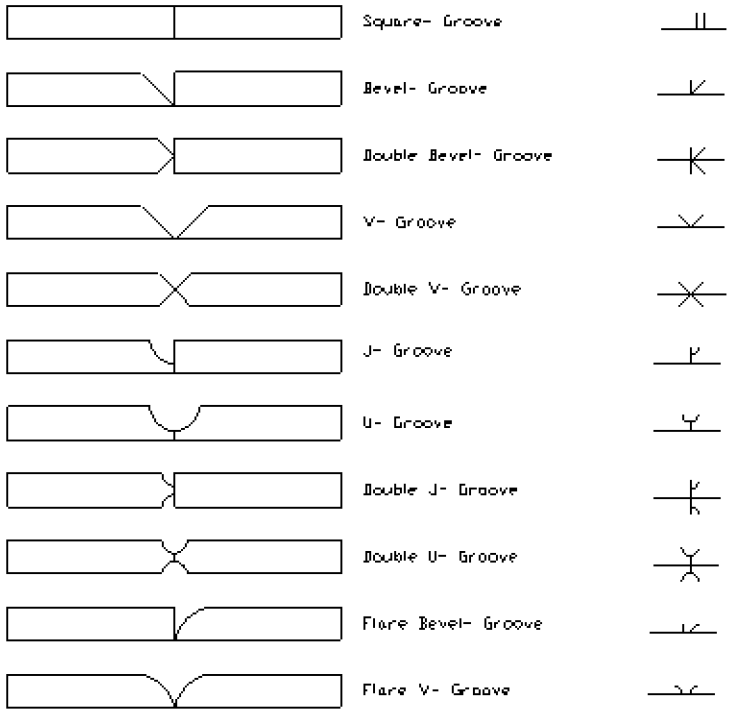
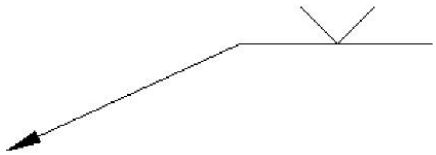
1.7: Groove Welding Symbols

A groove weld will be used when to parts come together in the same plane. These welds will be applied in a butt joint and may have a preparation or not before welding. This is the reason there are several types of groove welding symbols.

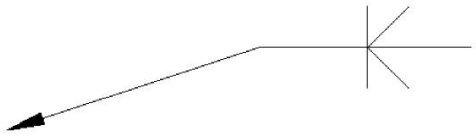


The symbols for these grooves are nearly identical to the symbols that represent them.

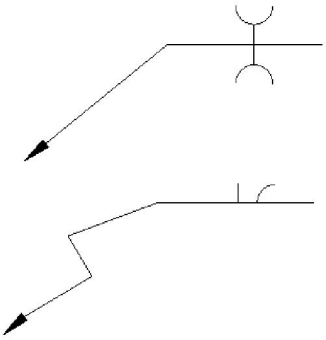
When a weld is to be applied to only one side of a joint it will be called a single groove weld. For example below is a welding symbol of a single V-Groove weld on the other side. All single groove welds should be considered complete joint penetration (CJP) unless otherwise specified.



If a weld is to be applied to both sides of the joint this is called a double groove weld. For example below is a welding symbol of a double bevel groove weld.

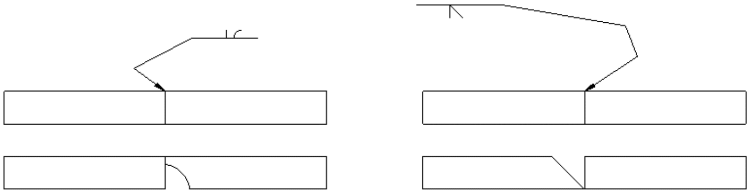


The theory behind the single groove weld and double groove weld translate to all of the groove weld symbols. It would be redundant to recreate all of these images.



What do these symbols call for?

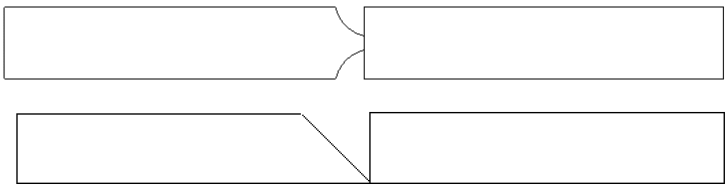
In some cases you will see a jog in the arrow. This is called a break in the arrow that will designate which side of the joint will be required to have the preparation done to it. For example if a single bevel is to be applied to the left side of the joint a broken arrow will be pointing specifically at that side of the joint.



If there was not an indicating arrow the welder or fitter would choose which side should be prepared according to their knowledge. This could be an issue if an engineer has specific needs for the part or weld.

Quiz

Draw the symbol representing the below groove and name it (don't forget to specify which side of the joint is prepared):

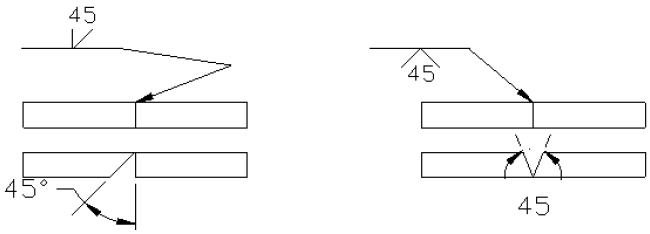


Draw the symbol for a V groove on the other side below:

Groove weld dimensioning

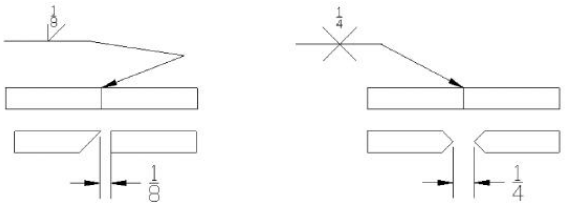
There are several dimensions that may be added to a groove weld if it is needed. This can include a groove angle, root opening, a groove radius, depth of the groove preparation, and groove weld size. There are times that this information may not be included at all. This would mean that it is the welder's discretion as to how the part will be prepared and welded.

Groove angle is shown in degrees and will include all of the groove, if it is a V Groove it will be a dimension from one groove face to the other. This can be confused with bevel angle. Bevel angle is only one half of a V groove. This dimension is shown within the weld symbol itself. There is a possibility for two different angles if you are applying to a double groove weld. The arrow and other side do not have to necessarily match in angles.

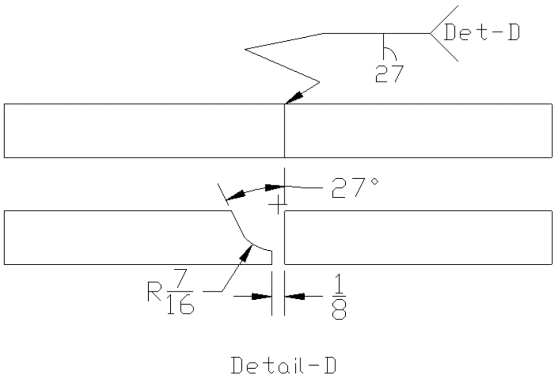


A groove weld is the most common weld to have a root opening. This is a gap that is predetermined to have between two members to be welded. There is not always a root opening and this dimension can be omitted from the welding symbol. It is common to put a

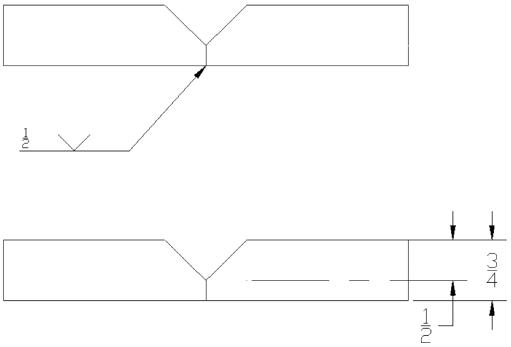
root opening on a part to ensure complete penetration or even melt through. The melt through symbol is included in supplementary welding symbols.



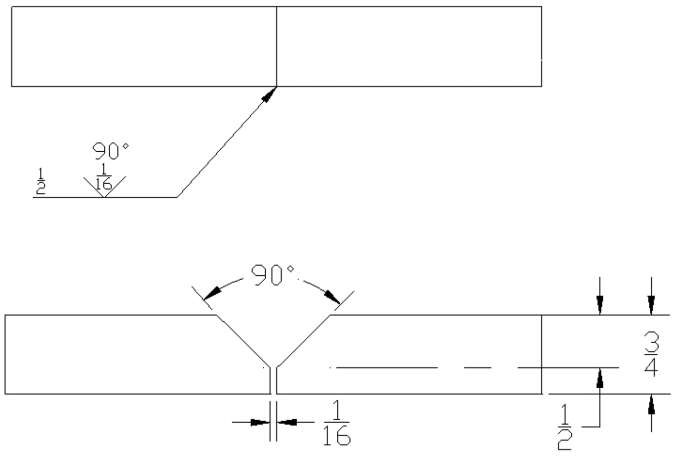
Grooves that associate with U and J preparations are a rather special weld. These welds if done to correct standards are machined with a specific radius of groove as well as root face. These dimensions must be shown in a detail or section view that is noted in the tail of the welding symbol.



The preparation of the groove may be called out for how deep you are to prepare the part. This is called the depth of groove. V-Grooves, j- grooves, and u- grooves are the most commonly sized welds for depth. Although this does not mean it cannot be applied to others. The dimension will be shown to the left of the weld symbol.

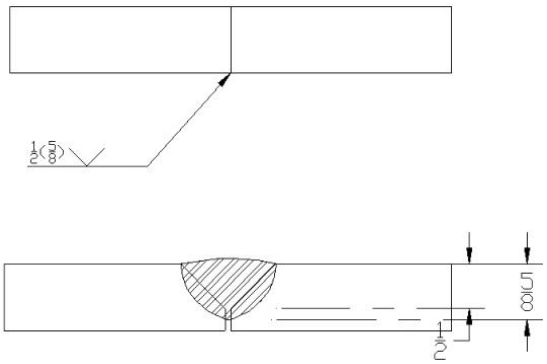


As we start adding more elements the symbols get fairly complicated looking. The easiest thing to do is slow down and look at each individual piece and apply it to what we have learned. For example the below weld is a single V-groove weld on the other side. This weld has a ½ inch groove depth, 1/16inch root opening, and 90 degree groove angle.

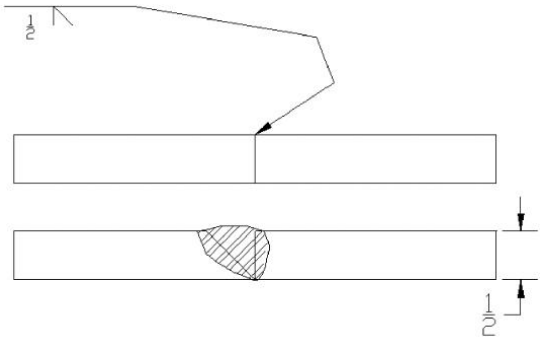


When using a groove depth that is not the full depth of the part we leave a flat area in the root. This area is called the root face. A more common term you will hear is the land. In the diagram above we have a ½ inch groove depth and we have a ¾ inch part. This leaves us a ¼ inch root face.

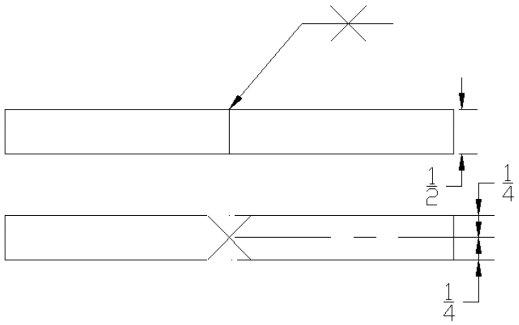
Often associated with a groove weld is going to be the weld size. This weld size is the depth of penetration you will be getting when applying the weld. When a weld is applied we should be melting into the root of the part so our weld should be larger in dimension than the preparation of the joint. This dimension will show to the left of the weld symbol. When paired with a groove depth the weld size will be within parentheses. If no weld size is shown the weld should be complete joint penetration.



In the case of a groove that shows a depth of groove preparation but the weld size does not show. The weld shall not be less than the depth of preparation. If you did not perform a weld that was at least this size you will not have completed adequate fusion or the weld will not fill the groove.

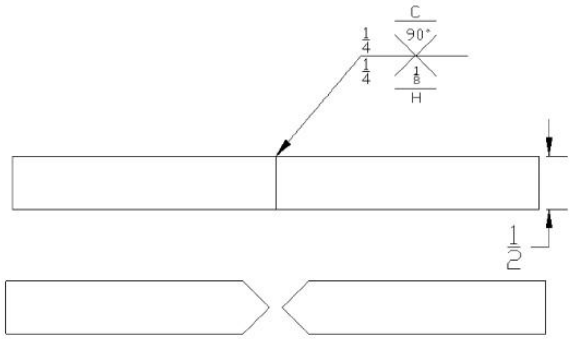


There are times when dimensions will not be shown on grooves. If the joint is symmetrical then the weld shall be complete joint penetration. This is easily pictured with a double v-Groove.

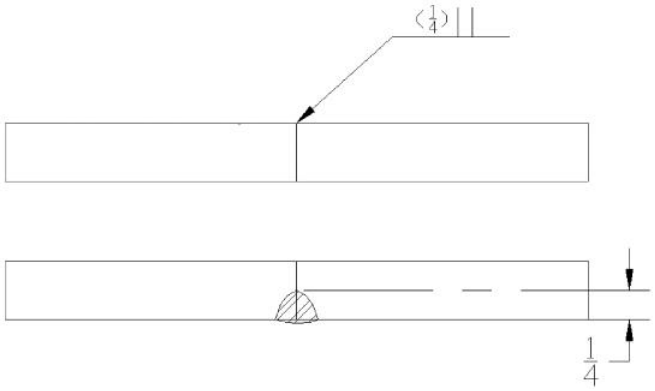


The above image shown is a double V-Groove weld. There is no groove depth shown so by welder's discretion the parts are prepped to ¼ inch on both sides to create a symmetrical joint.

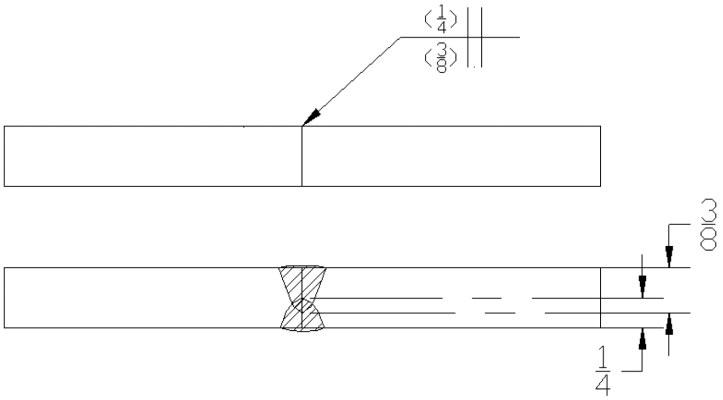
When working with a double groove that has the same dimensions on both sides it is required that dimensions are shown on both sides of the reference line. This is important because if one dimension is left off there will be an unknown size and this may compromise the weld.



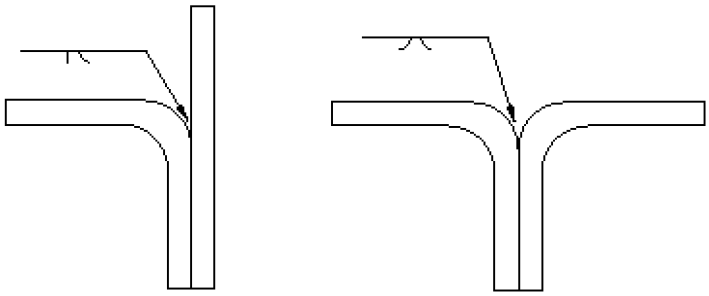
There are also times that a weld is not required to penetrate the depth of the groove. The easiest way to accomplish this would be to place a weld size dimension to the left of the weld symbol that is of smaller size than the material thickness.



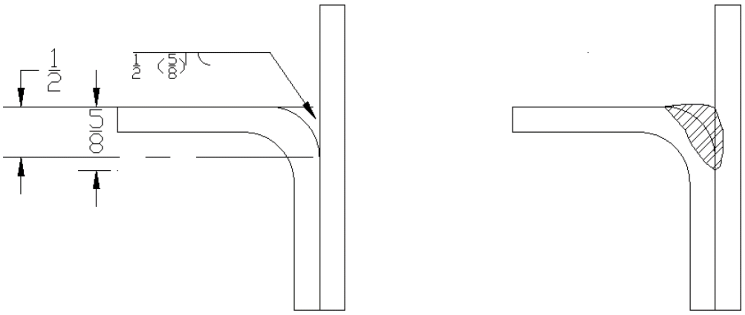
There may be a weld applied to both sides in order to get penetration through the groove thickness without preparation of the part. This is going to be limited to smaller thickness of material depending on the process that is used for the welding.



The two flare type grooves including a bevel and a Vee are going to be very common when working with sheet metal and also if there are welds being made to tubing that may have a large radius on the corners. This is fairly common in tubing that is ¼" and above in thickness. If working with sheet metal it is common to make a joint type of this type in order to fuse the parts together. Instead of using filler the material that is making the flare bevel may have a leg of an 1/8" or so and it will make up for the filler.



When using either of these symbols it is important to know the difference between the preparation of groove depth as well as the weld size. Similar to a regular bevel or vee the preparation of groove depth is going to be to the left of the weld symbol and also to the left of the weld size which will be shown in parenthesis. Length can be added in a dimension to the right of the weld symbol.

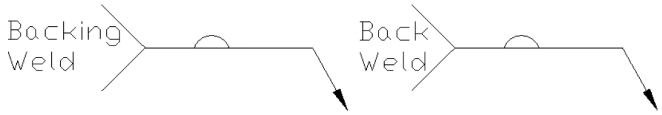


Back, Backing weld, Surfacing weld

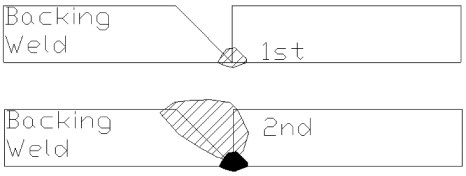
A back or backing symbol is the same for both, you must look in the tail for further information to distinguish between them.

A back weld is when a weld is made in the groove of a joint and followed by a weld applied to the root side. This is most commonly used to insure complete penetration on CJP grooves. The Back weld is usually applied after the root has been ground or gouged out to make sure that the weld is made to sufficient material. When trying to remember the difference between a back and backing weld, you must always go back in order to do a back weld.

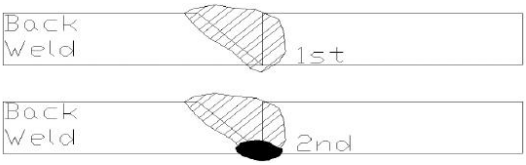
A backing weld is made on the root side of a groove in order to ensure that the weld that is going to be made in the groove does not melt through the backside. This may also help ensure CJP.



Below is a representation of a backing weld.



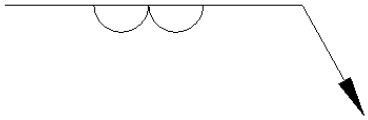
Below is a representation of a back weld.



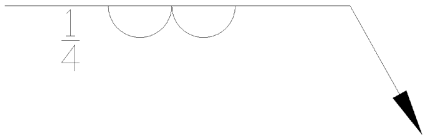
There are times where the tail will be omitted from the drawing and in the tail there will be a note that may say which order the welds are to be made. It may be as simple as “other side weld made first” or may include true terms such as “other side bevel groove welded before back weld on arrow side.”

Surfacing welds

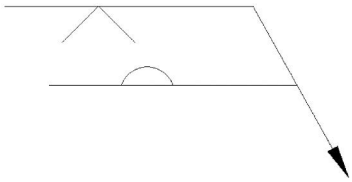
Surfacing welds are made by single or multiple passes to parts for a variety of reasons. These may include buildup of worn material, hard facing a part, or increasing part dimensions. This symbol may be on the arrow side of a joint only. It is important that the arrow points specifically where the surfacing shall be added.



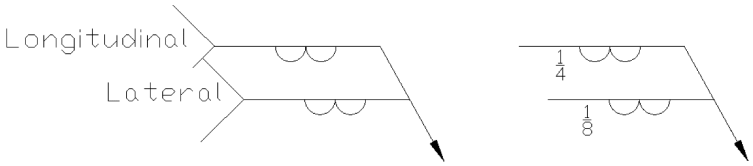
These welds may include a thickness of weld which will be located to the left of the weld symbol and may also show a length to the right of the symbol. With this type of weld it will more than likely have a detail view with dimensions for the welding.



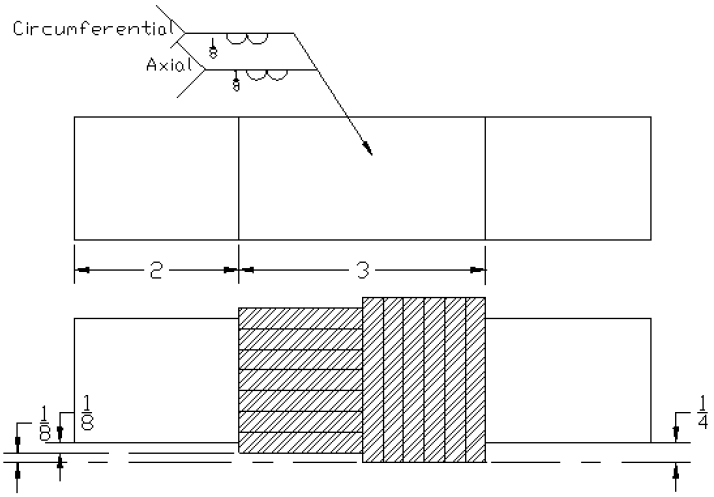
When a surfacing weld may need multiple layers this may be shown in a note on the blueprint or it could also be determined by the reference lines. There are times where there may be more than one reference line which gives it an order of operation. For example if you think of a backing weld this would be listed on the reference line which is closest to the arrow, the groove weld would be placed on the second reference line.



To show this in surfacing welds it may ask for a specific size for the first layer of buildup and then a different size for the second or subsequent layers. If there is a change in direction this may be shown in the tail of a multi reference welding symbol.



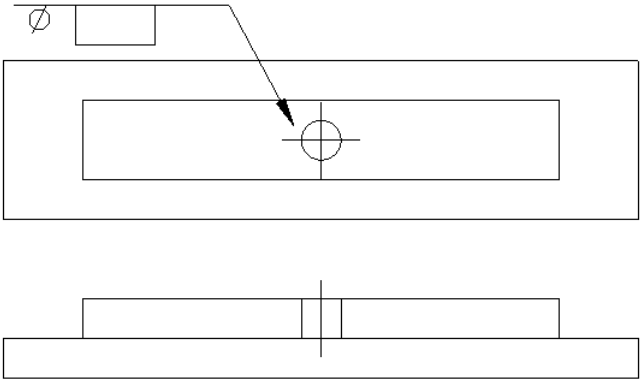
A surfacing weld will run the entire length of the part unless there is a dimension, note, or other designating it is not full. This also plays a part when welding a shaft or other round object. With a round object rather than a longitudinal (long dimension) or lateral (short dimension) of the part you may see axial (the length of the shaft) or circumferential (around the shaft.) When a weld will be done to a shaft or other round part this must be called out or an incorrect procedure may be applied.



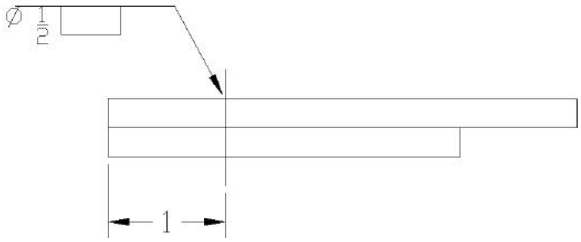
1.7: Groove Welding Symbols is shared under a CC BY license and was authored, remixed, and/or curated by LibreTexts.

1.8: Plug Weld symbols

Plug welds are a round weld that is made inside of an existing hole most commonly in one piece of metal, welding that piece to another member. The plug weld symbol is a rectangle with a diameter symbol placed to the left of the symbol as well as the number associated with that diameter.

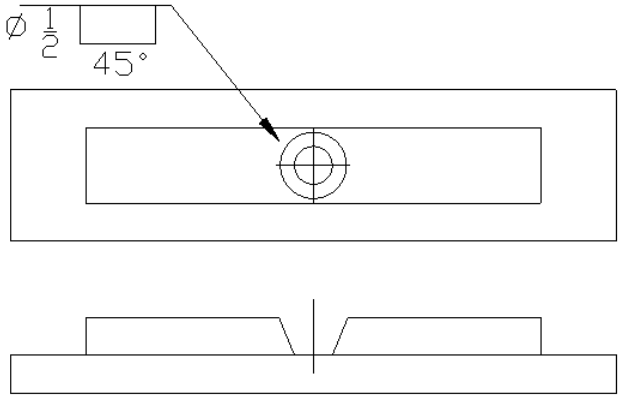


Some drawings will not indicate the hole in the print so the use of dimensions come in to play when locating where a plug weld will be executed. The location will be indicated by a centerline through the part.



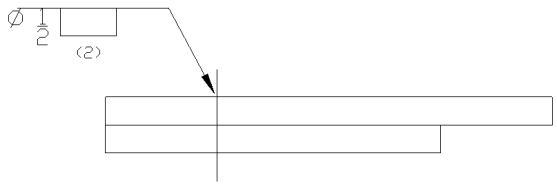
Above is indicating a ½" plug weld offset 1" from the edge to the center of the weld.

Some plug welds may include a countersink of the hole of the plug weld. This is called the included angle of countersink. This angle is shown below the rectangle of the symbol itself or if the plug weld is to be on the other side it will be placed above the weld symbol. When figuring sizing of the hole remember that the diameter will be the narrow of the hole at the base of the weld.

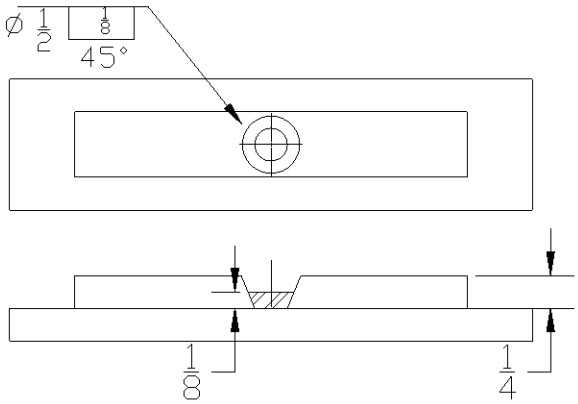


Without a countersink included it will be necessary to follow shop standards and procedures to dictate what this needs to be, if any angle. Most shops have a procedure in place for tasks that will be done often. If it is needed it may be listed on a welding procedure for the plug welds that are being completed.

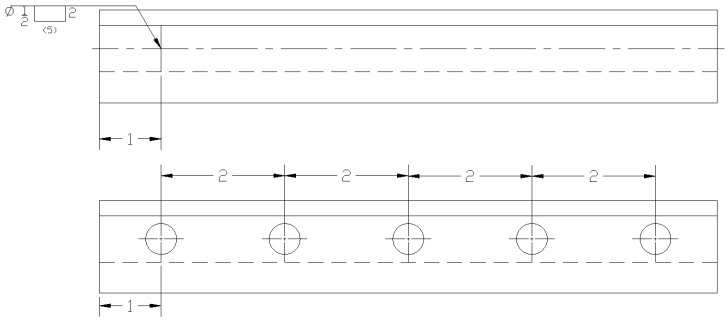
If a number of plug welds are needed there will be yet another element added to the symbol. This will be a number that is surrounded in parentheses, such as (6) for example.



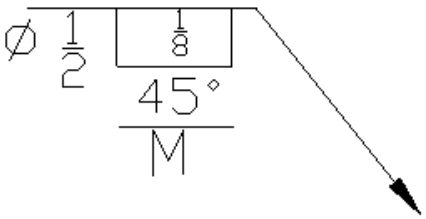
When applying a plug weld it is important to know the depth of fill that is required. If the plug weld should fill the hole provided then the symbol will be left empty. This means there will be no dimension inside of the rectangle. If the hole should be filled only so much then this will be placed inside of the rectangle. This dimension will be in a fraction and indicates the amount in inches the hole will be filled, not the necessarily how much the hole will be filled.



Another element that can be added to this weld symbol may be the pitch (spacing) for multiple welds. This is located to the right of the symbol and is a number representing the center to center spacing for weld location.



Plug welds may have a contour symbol which will be added below the symbol or countersink angle if on the arrow side and above if it is on the other side of the reference line. There are many types of contours and finishing designations, these are covered in supplementary welding symbols.



This symbol represents:

Plug Weld

Arrow Side

½ inch in diameter

1/8” amount of fill

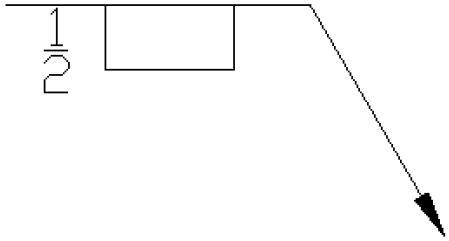
45 degree included angle of countersink

Flat contour

Finished by Machining

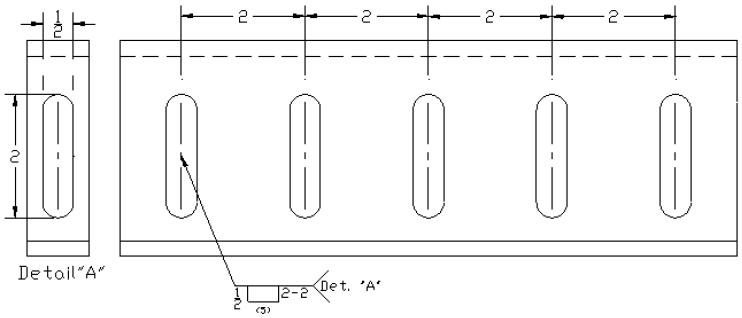
Slot Weld Symbol

The slot weld symbol is the same that is used for plug welds. The symbol will not show a diameter symbol before the size however. The size of the weld will be the slot width instead. This is shown to the left of the symbol just as it is shown in plug welds.

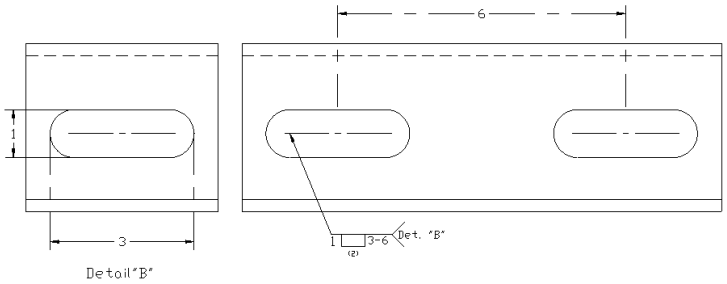


1/2” width slot weld

The length of the slot weld will be presented to the right of the symbol. This may also include a pitch showing the center to center spacing of the slot welds. If there is a pitch there will be a number of slot welds provided in parenthesis under the symbol on the arrow side or above the symbol on an other side weld.



The drawing must show the orientation of the slot welds as to not confuse direction along the part. The above image shows the slots with a vertical orientation to the part versus a horizontal layout as shown below.



A slot weld can include any number of elements, these are very similar to the plug weld symbol that was just explained.

These can include:

Arrow or other side

Size (width)

Length of slot

Pitch

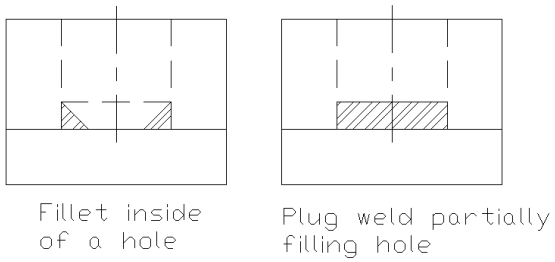
Depth of fill

Number of welds required

Contour

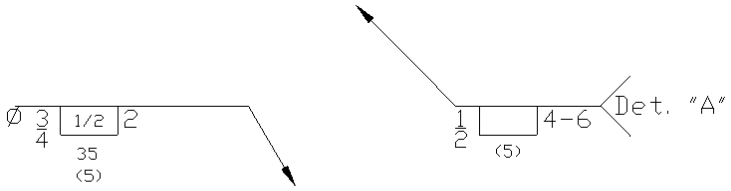
Finish

Make no mistake on the fill of a plug or slot weld fill. There is a possibility of having a fillet weld inside of a hole versus actually filling the hole for a plug weld. This could also be mistakenly done on a slot weld.



Plug and Slot Quiz

Write down all information regarding the below Welding Symbols.



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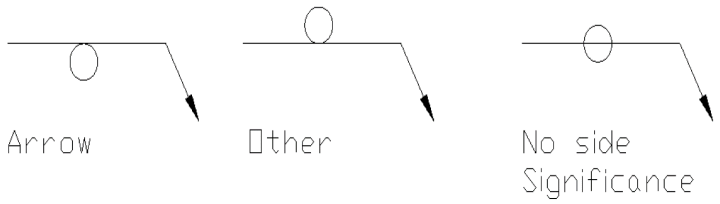
1.9: Spot, Seam, Stud Welding Symbols

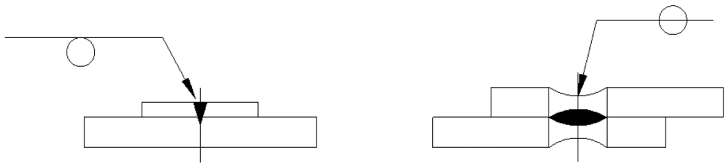
Spot Weld

The spot weld symbol is simply a circle that may be placed above, below, or centered on the reference line. When the symbol is centered on the reference line this indicates that there is no side significance. When there is no side significance this can commonly be applied using a resistance spot welder which is used widely in sheet metal work.

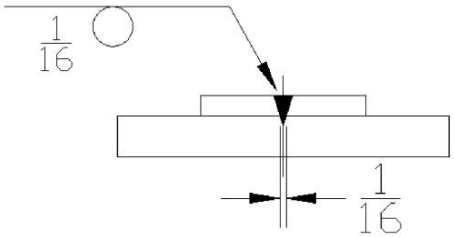
A spot weld is simple a weld applied to the surface of one member that has enough heat input to melt into the material that is creating the faying surface. This is done with no prior preparation to the parts.



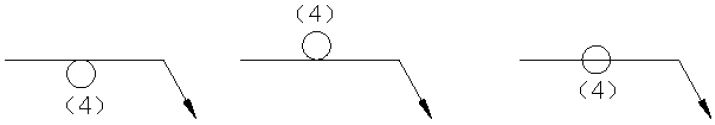
An example of arrow side spot weld and a no side significance resistance spot weld below.



The size of a spot weld is going to be placed to the left side of the welding symbol. This number indicates the diameter of said spot weld at the faying surface. The faying surface is where two parts are placed on top of each other at close proximity.



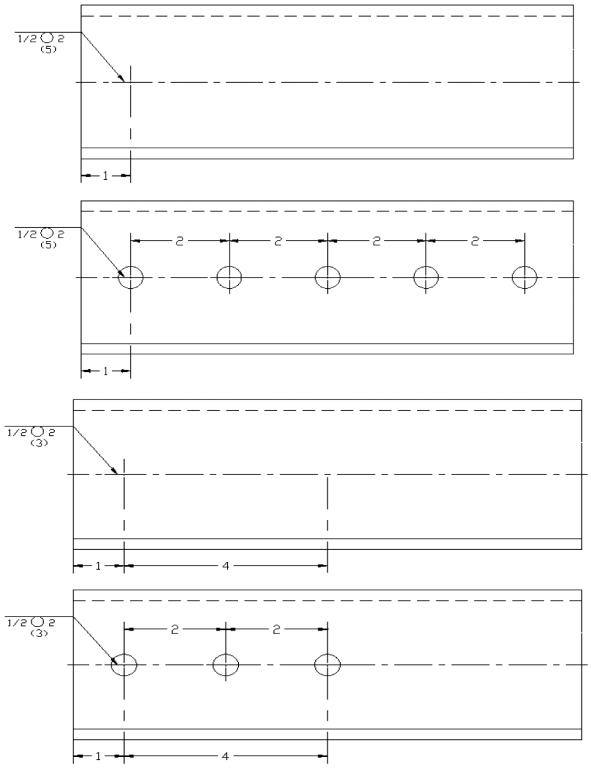
The number of spot welds required will be added in parenthesis above or below the symbol depending on location of the symbol. If it is centered on the reference line the placement of required welds could be placed above or below the symbol.



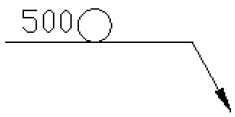
Pitch can be added to the spot weld symbol as well. This will be presented to the right of the symbol.

When a pitch is used this is stating that this will be continued across the full length of the part. For example if the part is 20 inches long you would be applying welds every 2 inches using the above symbol for the length of that 20 inch part. If the spot welding will not be covering the full length of the part this will need to be shown with dimension lines on the print in order to communicate this information properly.

Full length call out:



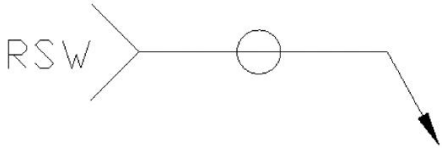
There are times when instead of using a diameter dimension the call out will be for shear strength. This is how resistant something is to shearing. This can be called out in pound-force (lbf) or if the blueprint is in metric it would call for Newton's (N).



This calls for a spot weld with 500 pound-force shear strength.

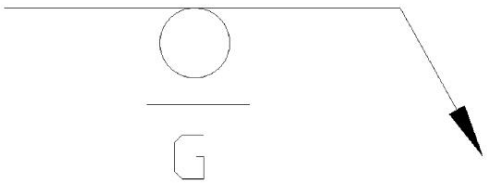
(500 lbf specifies that the part will be able to resist shearing to a minimum of 500 lbf.

It may be specified what process will be used to achieve the weld and this will be put into the tail. Common processes for this would be resistance spot welding, and gas tungsten arc welding. The reasoning behind these are there could be no added filler used with the weld so there will be less of a chance for lack of fusion. Many other processes may be used as long as the effects of the weld are known and still acceptable for the outcome of the weld.



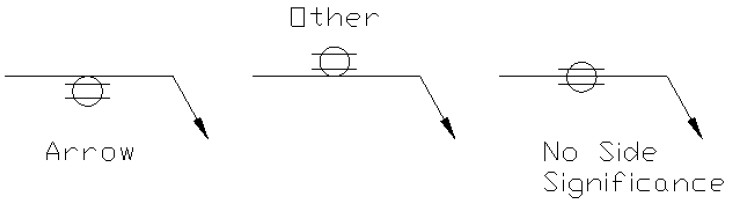
A contour may be added to the spot symbol in order to ensure that the surface is flush as if no weld has taken place. This will go into further detail in supplementary welding symbols.

For an example below is an arrow side weld with a flush contour by grinding.

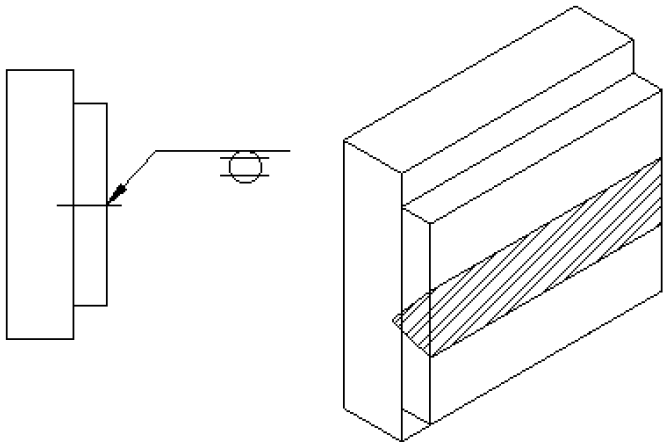


Seam Weld

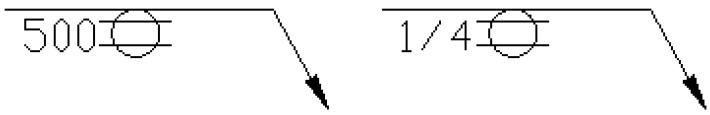
The seam weld uses a similar process as a spot weld but in an elongated fashion. There is no preparation like a plug or slot weld, rather the weld projects through the top surface and melts into the other member by means of heat input. The symbol is similar but it carries two parallel lines through it.



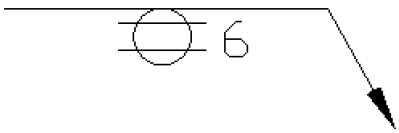
An example of a seam weld:



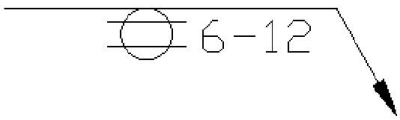
Seam welds will have a size or shear strength associated with the welding symbol commonly. This number will go to the left of the welding symbol. A size is an indication of width of the bead. Shear strength is the same as a spot weld and is the amount of pound-force the weld can take minimum per 1 inch of weld.



Length can be added to the right side of the symbol to indicate how long the weld to be made is.

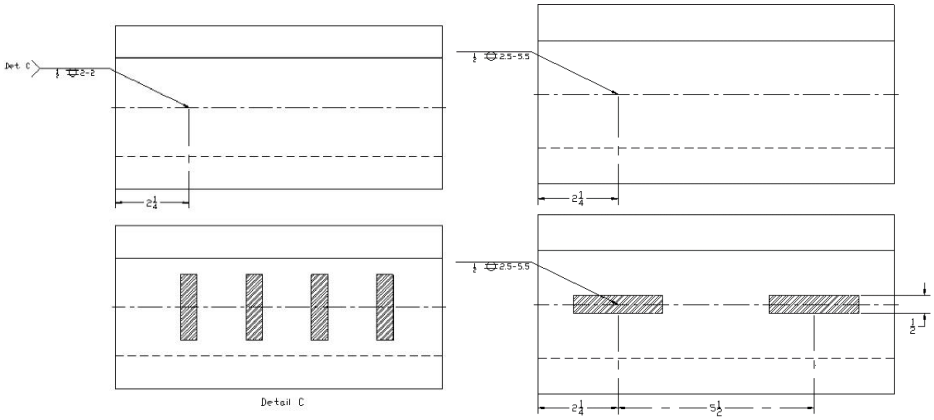


An additional element can be a pitch if it is needed for applying several welds. This will be added to the right side of the weld symbol after the length with a hyphen.



Seam welds can also have elements as spot welds do such as a process associated in the tail as well as a contour. The contour is shown above or below the symbol depending on the way the symbol is on the reference line.

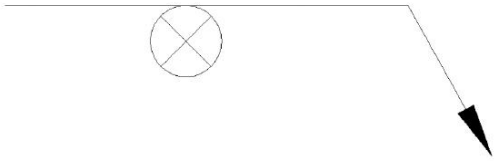
The next image shows a weld call out for a Seam weld on the arrow side. ½ inch in width with 2.5” segments and a 5.5” pitch. All intermittent welds (pitch) are made in a lengthwise pattern unless there is a detail on the print that says otherwise.



Stud Welds

Stud welds are a common practice in many shops. This process often uses a stud welder which is sometimes a standalone or handheld unit. These welds require the symbol to be on the arrow side only of a joint. The elements of size, pitch, and amount of stud welds are placed in the same locations as spot and seam welds.

Symbol



Added elements

The above weld is calling for six ½” diameter stud welds placed at a 4” center to center spacing.

Studs come in all sorts of sizes, shapes, and varieties. For example there are studs for concrete anchors, threaded bolt patterns, tapped studs to use as a bolt, insulation hangers, and even hard faced studs to replace hard facing a part.

Spot, Stud, Seam Quiz

In the space below draw a symbol for the following:

3/16” spot weld on the arrow side, ground flush, a pitch of 2”, and 8 total welds.

1” Stud welds on the arrow side, 2” pitch, 20 total studs.

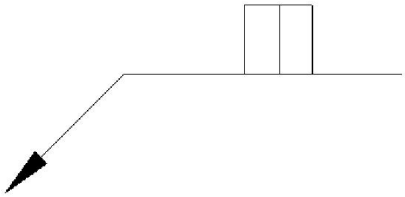
Resistance seam weld with no side significance, 8” pitch, 16” length.

1/4” stud welds on the arrow side with a pitch of 2”. If the part is 20” long and the first stud is placed 1” from the edge how many studs are required?

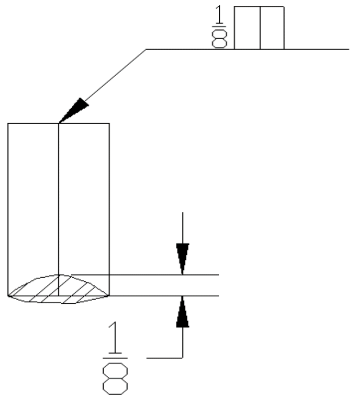
1.9: Spot, Seam, Stud Welding Symbols is shared under a CC BY license and was authored, remixed, and/or curated by LibreTexts.

1.10: Edge Weld Symbols

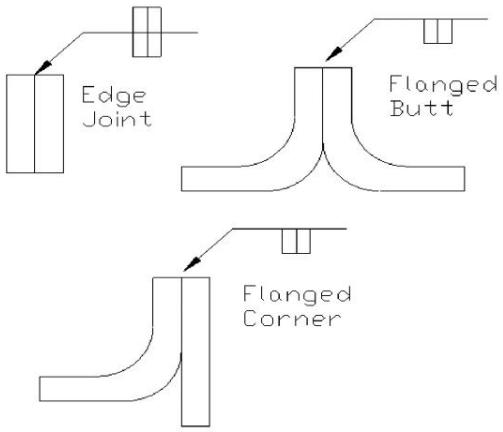
Edge weld symbols are most commonly associated with sheet metal or “gauge” material. This gauge is a system used in order to call out sheet metal similar to that of electricians and wire. This chart can range from the largest gauge of carbon steel at #7 which is a decimal of .1793” all the way to the smallest which is #28 at a decimal of .0149.” This system is much simpler than using a fraction for how small these numbers are. It is also important to know that there are specific charts for carbon steel, aluminum, stainless steel, brass, copper, and galvanized steel.



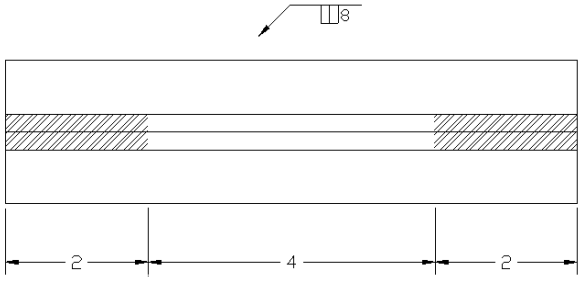
The edge weld may include a weld size which will be shown to the left of the weld symbol. The weld size is a measurement of depth of fusion, not necessarily the width of the weld. This does not mean these dimensions couldn’t be the same. If there is not a size specified it will be up to the welder’s discretion.



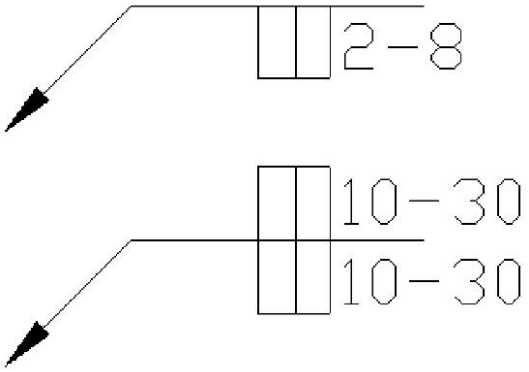
Single sided edge welds are used on edge joints, flanged butt joints, and flanged corner joints. If there is a double edge weld it will be used only with a flat edge joint. This is shown below:



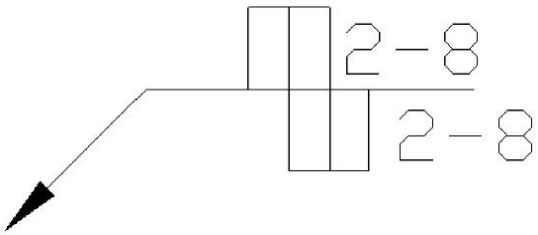
For edge welds a length can be associated with the symbol and it will be shown to the right of the weld symbol. If there is not a dimension shown to the right it will be full length of the part. There may be other indicators shown on a print of what weld length is required by using hatching or notes. Below shows an edge symbol with an 8” length as well as a detail view of a part to show specifically where two 2” welds will be located.



In chapter 3 Fillet Welds there was a section on length and pitch. An edge weld can also be welded in this same manner. This will be shown to the right with length followed by a hyphen and then the pitch. This can also include a chain intermittent edge weld for an edge joint. This will be more common with thicker material when it is a lengthy weld.

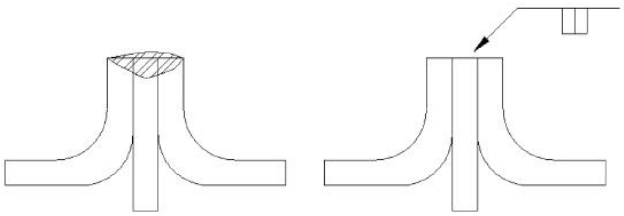


There may be a staggered intermittent edge weld as well. This is shown the same as a chain intermittent edge weld but the symbols will be offset.

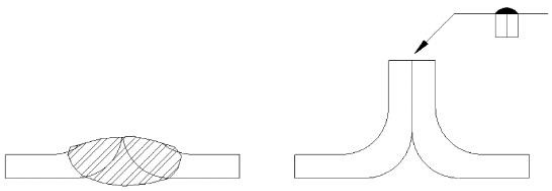


When the location for these welds are not obvious it will be called out on the blueprint. This may come from a note or detail drawing or even by using extension lines.

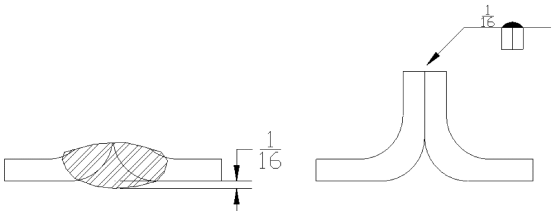
Some edge welds will be including more than 2 members. In this case there will be only one arrow that points at the joint but encompasses all of the members. This will be more common with sheet metal.



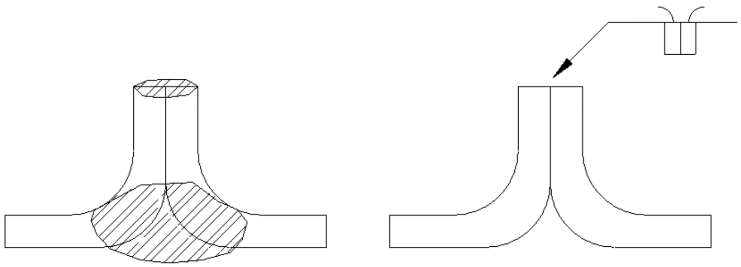
With an edge joint on a flanged butt joint or corner joint there could be the possibility of melt through. This is talked more in detail in Supplementary Symbols. When this symbol shows it is an indicator that the weld is by design supposed to burn through the back side of the material. This is quite common with sheet metal when the worry of burning a hole or something of the sort is a concern.



Melt through may be left as simple as the symbol or it may include a size. This is shown to the left of the symbol and indicates how much penetration past the weld joint is required. This is referred to as melt-through.



Another type of weld that is commonly seen with an edge weld is a flare bevel or flare v groove. This is because the opposite side of the edge is exactly that type of configuration. This may be called for on materials that adequate melt through cannot be achieved or an engineer's request.



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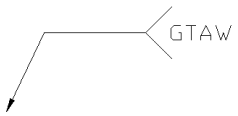
1.11: Process and Method

Type	Process	Designation
Arc Welding		
	Shielded Metal Arc Welding	SMAW
	Gas Tungsten Arc Welding	GTAW
	Gas Metal Arc Welding	GMAW
	Gas Metal Arc Welding Pulsed	GMAW-P
	Flux Cored Arc Welding Gas Shielded	FCAW-G
	Flux Cored Arc Welding Self Shielded	FCAW-S
	Submerged Arc Welding	SAW
	Plasma Arc Welding	PAW
	Electro slag Welding	ESW
	Electro gas Welding	EGW
Gas Welding		
	Oxyacetylene Welding	OAW
Brazing		
	Torch Brazing	TB
	Furnace Brazing	FB
	Induction Brazing	IB
Cutting		
	Oxyacetylene Cutting	OFC-A
	Air Carbon Arc Cutting	CAC-A
	Plasma Arc Cutting	PAC
	Arc Cutting	AC
	Gas Metal Arc Cutting	GMAC
	Oxygen Cutting	OC
	Gas Tungsten Arc Cutting	GTAC

There are a lot of processes in the welding industry, in order to streamline the call out of these there are letter designations for them. This designation is a letter callout and it commonly follows the first letter of the process name. For example Flux Cored Arc Welding is FCAW.

When a process is specified it will be located in the tail of the welding symbol. This can be added to several other components on the welding symbol.



Method

The method by which the weld is applied may also be listed in the welding symbol. This will often be seen after a process with a hyphen. There are four different methods of applying a weld and the designation is the first two letters from the first word for the

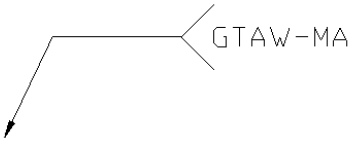
first three. Number Four comes from the first two letters of the hyphenated words. These methods vary depending on process and may not be applicable to all welding processes.

Automatic WeldingAU

Manual WeldingMA

Mechanized WeldingME

Semi-Automatic WeldingSA



The above image shows a Gas Tungsten Arc Weld process using a Manual method.

Also included in the tail could be a reference to a drawing number, a welding procedure (commonly called out as WP,) filler material, or any other pertinent information that may need to be communicated to the welder or fitter.

Examples of this information:

Drawing Number 5DWG5

Welding Procedure 6WP-6

Gas Tungsten Arc Welding – Manual ER70-s FillerGTAW-MA

ER70-s

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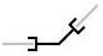
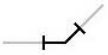
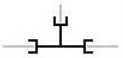
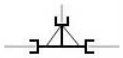
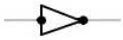
1.12: Pipe Symbols

Pipe Drawings are much different from specific weld symbols but they do have a similar relationship from part to symbol. Some individuals will not see these in their line of work but it is important to be aware of them.

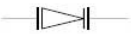
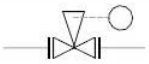
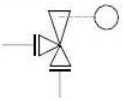
As with weld symbols, pipe symbols are a reflection of what that part would look like in theory. For example if a 90 degree elbow is to be placed in service the drawing will reflect a 90 degree angle. There may be multiple symbols for one fitting or part depending on the fashion it is to be installed (Butt weld, Socket Weld, Threaded.)

Below is a breakdown of almost every type of fitting and connection.

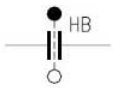
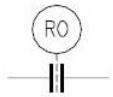
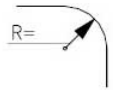
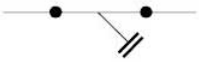
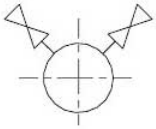
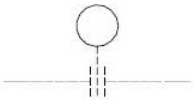
Coordination System Symbols for Isometrics

Image	Fittings	Butt weld Symbol	Socket Weld Symbol	Threaded Symbol	Fittings	Image
	Elbow 90°				Elbow 90°	
	Elbow 45°				Elbow 45°	
	Tee equal				Tee equal	
	Tee reducing				Tee reducing	
	Cap				Cap	
	Reducer concentric		...	...	Reducer concentric	...
	Reducer eccentic		...	...	Reducer eccentic	...
Image	Fittings	Butt weld Symbol	Socket Weld Symbol	Threaded Symbol	Fittings	Image

Flanges	Weld Neck	Socket Weld	Threaded	Slip-On	Lap-Joint	Blind	Flanges
Symbol							Symbol
Image							Image
Flanges	Weld Neck	Socket Weld	Threaded	Slip-On	Lap-Joint	Blind	Flanges

Image	Valves	Butt weld Symbol	Flanged Symbol	Socket or Threaded Symbol	Valves	Image
	Gate				Gate	
	Globe				Globe	
	Ball				Ball	
	Plug				Plug	
	Butterfly			...	Butterfly	
	Needle				Needle	
	Diaph	...			Diaph	
	Y-type				Y-type	
	Three way				Three way	
	Check				Check	
	Bottom	...		...	Bottom	
	Relief	...		...	Relief	
	Control straight	...		...	Control straight	
	Control angle	...		...	Control angle	
Image	Valves	Butt weld Symbol	Flanged Symbol	Socket or Threaded Symbol	Valves	Image

Miscellaneous	Symbol	Image	Miscellaneous
Branch outlet Weldolet®			Branch outlet Weldolet®
Branch outlet Nipolet®			Branch outlet Nipolet®
Flanged branch outlet Flangolet			Flanged branch outlet Flangolet

Miscellaneous	Symbol	Image	Miscellaneous
Spade			Spade
Spectacle blind			Spectacle blind
Hammer blind			Hammer blind
Spacer			Spacer
Restriction orifice			Restriction orifice
Field Weld			Field Weld Butt weld
Butt weld			
Pipe to pipe connection			Pipe to pipe connection
Pipe bend with special radius			Pipe bend with special radius
Sight glass			Sight glass
Direction of hand wheel wrench			Hand wheel
Y-type strainer			Y-type strainer
Conical strainer			Conical strainer
Conical strainer built-in			
Orifice assembly (typical) showing position of taps			Orifice assembly
Meter run orifice assembly (typical) flanged / butt weld			Meter run

Note: Symbols are shown in black lines. Lighter lines show connected pipe, and are not parts of the symbols.

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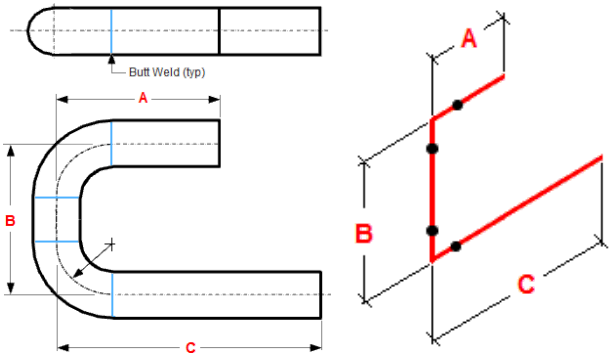
1.13: Pipe Drawings

Pipe drawings differ from common blueprints one would see in the construction or welding field. The drawings we often see in these fields would be orthographic views which may include top, front, right side, left side, bottom, and back views depending on what is needed to convey information. Pipe drawings are presented in an Isometric view (ISO.) This view is drawn in order to show a pictorial view of what is needed. Commonly these are drawn at a 30 degree angle from the horizontal plane. This can cause some distortion in dimensions so it is imperative that the correct dimensions are shown.

The image below shows a orthographic view of a butt welded pipe with three sizes (A, B, C).

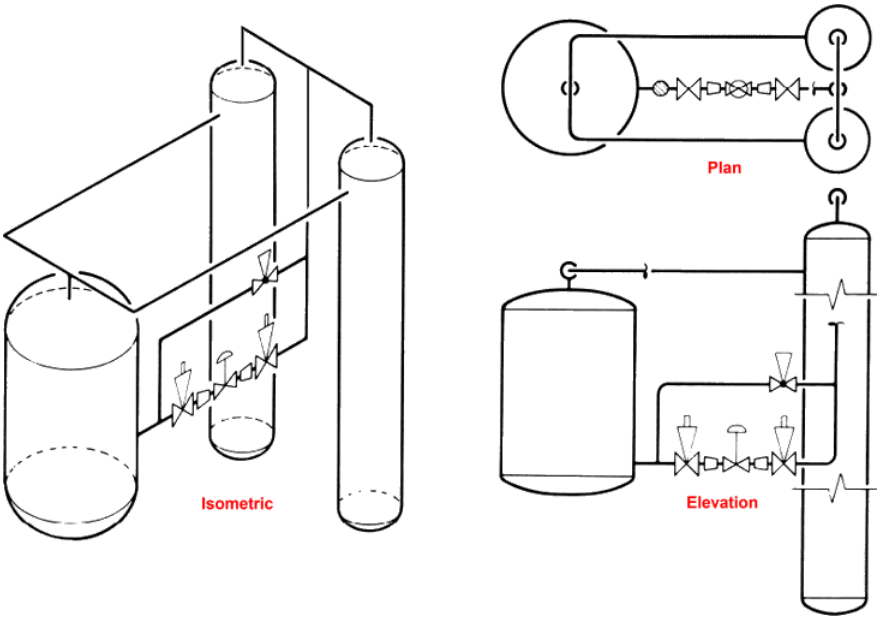
- The A size is measured from the front to the center line of the elbow / pipe.
- The B size is measured from centerline to centerline.
- The C size is like the A size, measured from the front to the center line of the elbow / pipe.

ORTHOGRAPHIC VIEW
(DOUBLE LINE PRESENTATION) ISOMETRIC VIEW



Isometric, Plan and Elevation Presentations of a Piping System

The image below show the presentation used in drafting. The isometric view clearly show the piping arrangement, but the plan view fails to show the bypass loop and valve, and the supplementary elevation view is needed.



Isometric views in more than one plane

Below are some examples of isometric drawings. The auxiliary lines in the shape of a cube, ensure better visualization of the pipeline routing.

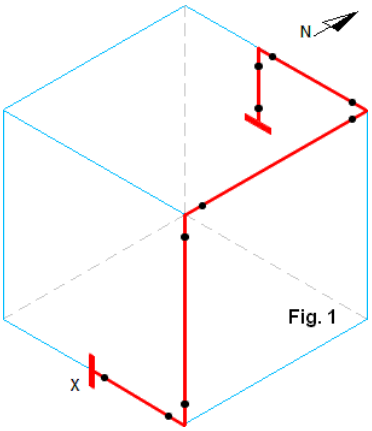


Figure **1** shows a pipeline which runs through three planes. The pipe line begins and ends with a flange.
Routing starting point **X**

- pipe runs to the east
- pipe runs up
- pipe runs to the north
- pipe runs to the west
- pipe runs down

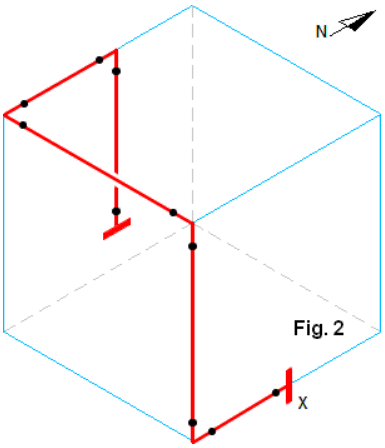


Figure **2** is almost identical to the drawing above. A different perspective is shown, and the pipe that comes from above is longer. Because this pipe in isometric view, runs behind the other pipe, this must be indicated by a break in the line.
Routing starting point **X**

- pipe runs to the south
- pipe runs up
- pipe runs to the west
- pipe runs to the north
- pipe runs down

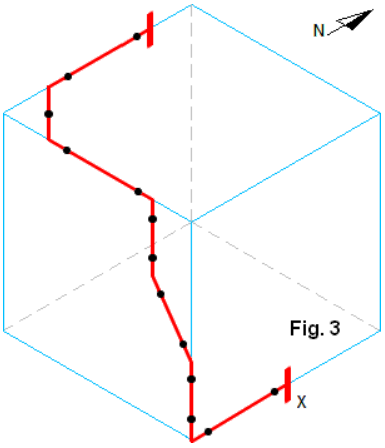


Figure **3** shows a pipe that runs through three planes and in two planes it make a bow.
Routing starting point **X**

- pipe runs to the south
- pipe runs up
- pipe runs up and to the west
- pipe runs up
- pipe runs to the west
- pipe runs to the north-west
- pipe runs to the north

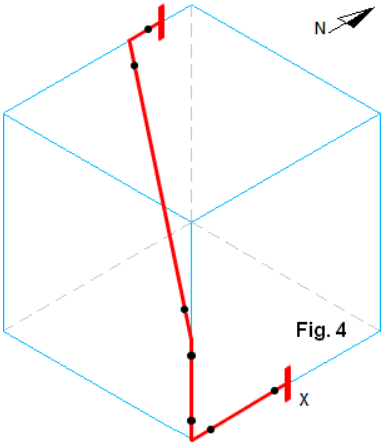


Figure **4** shows a pipe that runs through three planes, from one plane to a opposite plane.
Routing starting point **X**

- pipe runs to the south
- pipe runs up
- pipe runs up and to the north-west
- pipe runs to the north

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